AD-A131 445 LIMITED PERFORMANCE AND FLYING QUALITIES VALIDATION OF THE SGM 2-37 POWERED SAILPLANE(U) AIR FORCE ACADEMY CO K R CRENSHAW ET AL. JUN 83 USAFA-TN-83-9 1/2

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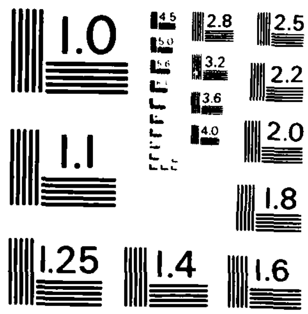

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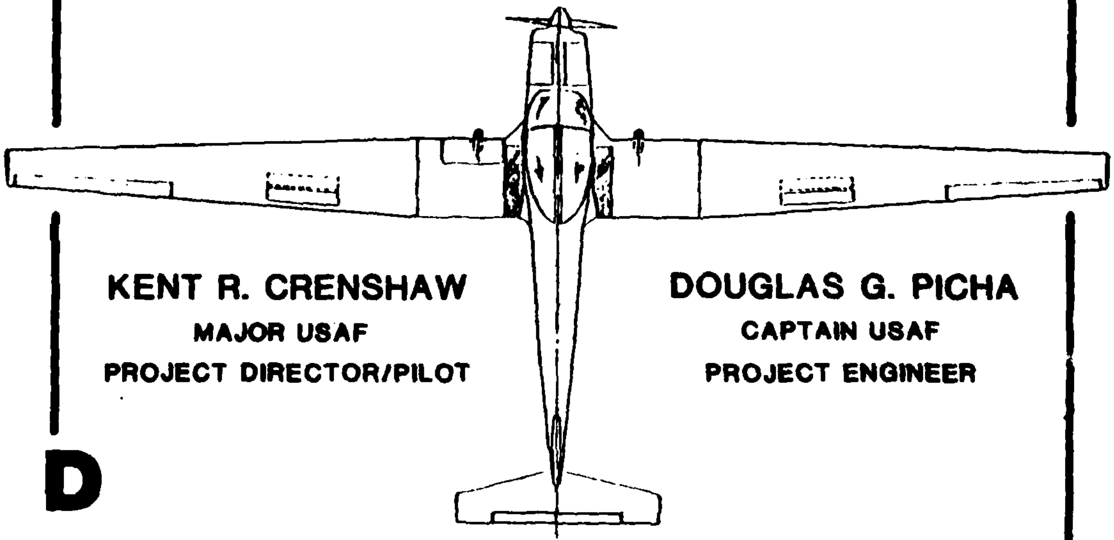

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FORWARD

This report along with the planning and flying of the SGM2-37 validation program which preceded it, would not have been possible without the truly outstanding support of several people assigned to Cadet Wing Operations and to the Soaring Branch of Airmanship at the U.S. Air Force Academy. Instrumentation and special equipment requirements were provided through the timely and creative efforts of Mr. Robert S. Christiansen along with his associates Mr. Douglas O. Curry, Mr. Glenn T. Stevenson, and Mr. Leon E. Essex. These individuals also efficiently handled all maintenance requirements for the aircraft. On the operational side, special thanks also go to Major Frederick L. Madsen, Captains Charles C. Flynn, Randy W. Roberts and Timothy J. Taylor for coordinating logistical and scheduling requirements, supervising flying requirements, and assisting in my checkout in the aircraft as well as in the evaluation effort itself. Last, but certainly not least, thanks go to Captain Douglas G. Picha, flight test engineer for his planning of each mission's data requirements along with subsequent data reduction and plotting of selected flight parameters. He proved to be an invaluable asset both in the air and on the ground in assuring that all data requirements were gathered, processed, and analyzed accurately using accepted engineering practices. The cooperation of these individuals and several others was instrumental in contributing directly to the successful and safe completion of the SGM2-37 validation program.

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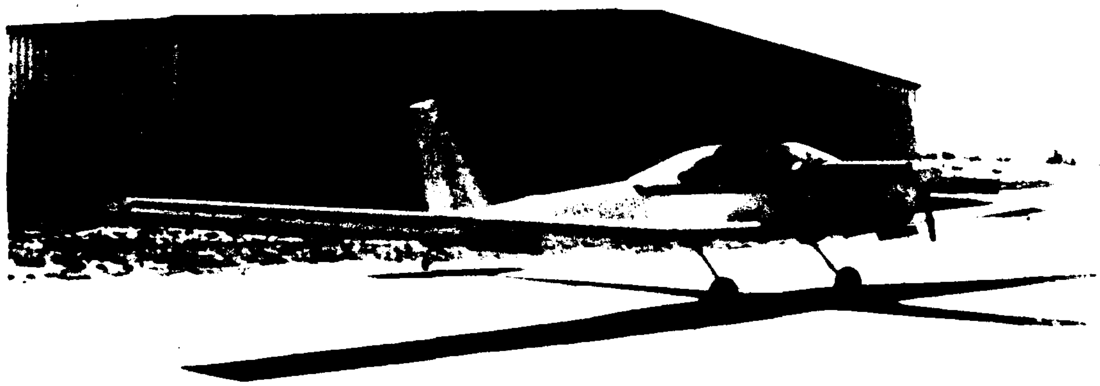
ABSTRACT

A limited performance and flying qualities validation of the SGM2-37 powered sailplane was conducted in order to verify contract requirements and to evaluate the overall capability of the aircraft to satisfy mission requirements. After verifying the calibration of the pitot-static system, the program was accomplished in three phases-performance, flying qualities and operational handling. The SGM2-37 aircraft meets all contract requirements except for exceeding the maximum takeoff ground run of 1000 feet; the minimum sink rate 240 feet per minute, exceeding the approach glide slope of 7 to 1 and failing to achieve a wings level stall speed between 35 and 45 mph. Failure to meet these requirements was not objectionable and did not detract from the operational capability of the aircraft. Problems with cockpit control movement of the left seat airbrake handle and with the control stick were identified along with eratic and inaccurate fuel quanitity indicator displays. Currently, the aircraft maximum certified gross weight of 1760 pounds is not high enough to accomodate a full fuel load along with all combinations of crew weight and equipment requirements. In addition to suggested solutions to cockpit control and fuel gage problems, and a recommendation to increase the maximum gross weight of the aircraft, several warning and caution notes were recommended for inclusion in the Operating Handbook in order to enhance ground and in-flight safety as well as crew comfort. Generally, the aircraft should prove to be an outstanding addition to the U.S.Air Force Academy's Soaring Program.



I. <u>Introduction</u>

A limited evaluation of the performance, flying qualities and operational handling of the SGM 2-37 powered sailplane was conducted in order to prepare the aircraft for integration into the USAF Academy's Soaring Program. The overall objectives of this evaluation, as stated in the <u>Validation Plan</u> (1), were to:

(a) verify that the SGM 2-37 powered sailplane meets the performance, flying qualities, and operational handling requirements of the "Statement of Work" provided by Headquarters Aeronautical Systems Division (ASD) (2),

(b) verify selected performance characteristics found in the manufacturer's Operating Handbook (3), and

(c) determine the overall operational suitability of the SGM 2-37 in light of mission requirements.

Specific objectives for each of the three areas evaluated are contained in the Validation Results section of this report.

The validation program was conducted in three phases: performance, flying qualities, and operational handling. Overlap among the phases occurred throughout the program in order to take full advantage of aircraft availability and favorable weather conditions. Two aircraft were flown during the evaluation: registration numbers N31AF and N32AF. Eleven sorties were flown for a total flying time of 19 hours. A complete listing of each sortie flown is shown in Table A1 of Appendix A.

With two exceptions, all program objectives as defined in Ref. 1 were completed. Sawtooth climbs at 8,000 and 9,000 feet and flights with centers of gravity at the aft limit were not accomplished due to time constraints and for practical considerations discussed later in this report.

All flying was accomplished from 27 April to 27 May in the vicinity of the USAF Academy Airfield and Peterson Air Force Base during visual meteorological conditions (VMC) only. All maneuvers and operations were performed within the limitations prescribed in the Operating Handbook and in accordance with local flying regulations.

II. Validation Results

A. Aircraft Description

The SGM 2-37 powered sailplane, shown in Figure 1, is manufactured by Schweizer Aircraft Corporation of Elmira, New York. It is certified in the utility category at 1,760 pounds gross weight. Acrobatic maneuvers, including spins, are prohibited. The aircraft is an all metal, low-wing design with side-by-side seating for two crew members. All controls, including airbrakes, are mechanical and fully reversible. The horizontal stabilizer is all movable with a leading tab that also serves to trim out longitudinal control forces. The aircraft is powered by one Lycoming O-235-L2C reciprocating engine rated at 112 horsepower (HP) at 2,600 revolutions per minute (rpm). The engine drives an all-metal, Sensenich fixed-pitch propeller. The SGM 2-37 is capable of visual, daytime operation only. Both aircraft flown during this evaluation are considered representative of the production aircraft described in the Operating Handbook and in Appendix B.

B. Instrumentation

Only aircraft registration number N31AF was modified with the installation of additional instrumentation for measuring selected in-flight parameters. N32AF was flown with the standard, operational assortment of instruments. As shown in Figure 2 the instruments added to N31AF consisted of an outside air temperature (OAT) gauge, manifold pressure (MAP) gauge, and

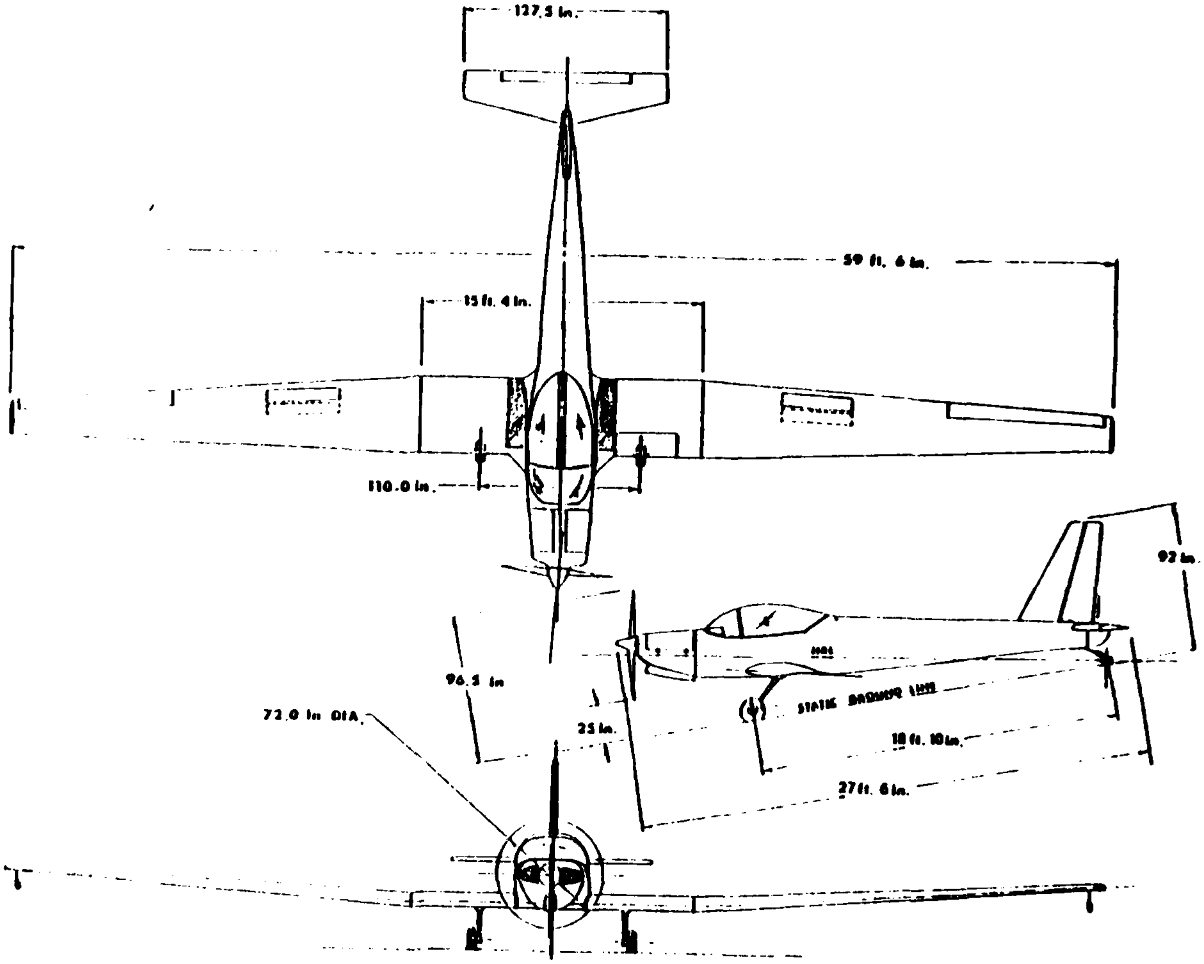


Figure 1. SGM 2-37 General Arrangement (3:1-2)

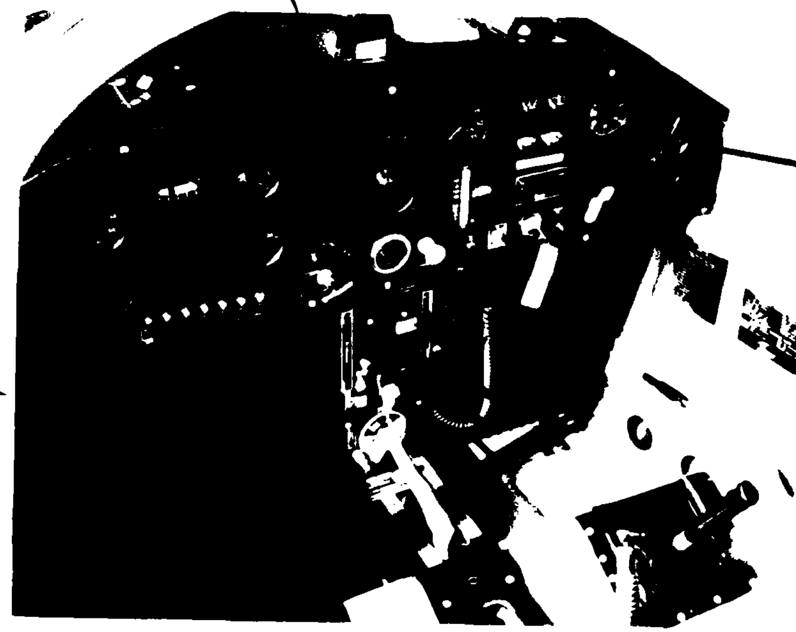


Figure 2. Cockpit Layout and Instrumentation in N3[illegible]

accelerometer. A hand-held calibrated force gauge and a tape measure were carried on selected flights in order to measure control stick forces and displacements. A stopwatch was used to measure climbs, descents, accelerations, and dynamic characteristics, and for pitot-static calibration runs. A cassette tape player was found to be particularly useful for recording qualitative comments.

C. Data Reduction

All test data was reduced to standard atmospheric conditions and a standard weight of 1,760 pounds using the formats shown in Appendix C. Where required by Ref. 2, data was extrapolated to 10,000 feet density altitude. Computer support was provided by a programmable T1 58C calculator built by Texas Instruments.

D. Test Methods and Conditions

Data sorties, summarized in Table A1, were flown in accordance with the Validation Plan (1). While this was not a flight test program, commonly recognized and approved flight test techniques were used in order to validate the performance and flying qualities of the SGM 2-37. Specific flight test techniques are discussed in the "Initial Flight Test Reports" in Appendix D and in Refs. 4 and 5. All flights were conducted within the limitations stated in the Validation Plan (1:10),

the Operating Handbook (3:2-1 to 2-11) and in accordance with USAFA Regulation 55-4 (6).

E. Objectives, Results, and Analysis

1. Pitot-Static Calibration

Pitot-static calibration runs were flown in order to:

(a) verify the airspeed calibration data presented in the Operating Handbook (3:5-3) and

(b) investigate the effect of position error by flying with airbrakes extended.

All objectives were achieved. The pitot-static system of the aircraft was calibrated using a 1.7 statute mile ground course north of the Academy on an east/west heading. The aircraft was flown at 7,500 feet pressure altitude at selected airspeeds from 55 to 110 mph. Calibration runs were flown with airbrakes retracted and with airbrakes extended. For both airbrake configurations the position error for the pitot-static system was found to be negligible. The airspeed calibration data, shown in Figure 3, lies almost exactly along the calibration curve supplied by the manufacturer. In addition, no measureable difference in position error was found by flying the aircraft in different airbrake configurations.

2. Performance

The objectives of the performance phase of the validation program were to

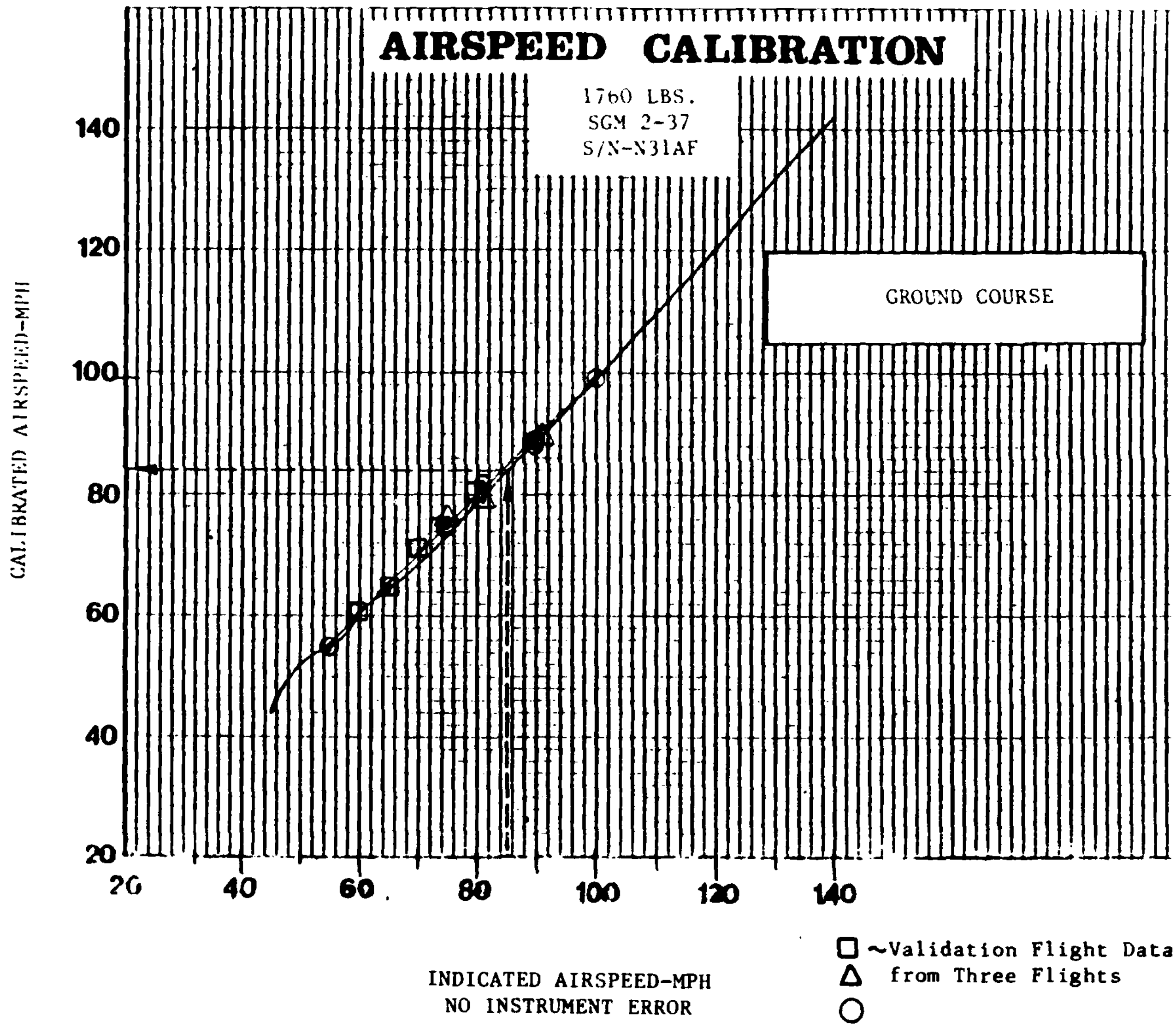


Figure 3. Airspeed Calibration Data

(a) verify the no-wind takeoff ground run from a dry, hard surface at 10,000 feet density altitude as being 1,000 feet or less (2:2),

(b) verify that the aircraft is capable of at least a 400 feet per minute rate of climb at 10,000 feet density altitude (2:2),

(c) verify that the idle-thrust glide ratio is at least 20 to 1 (2:3),

(d) verify the power-off performance polar in the Operating Handbook (3:5-5),

(e) verify that the approach glide ratio in idle thrust with airbrakes fully extended is not flatter than 7 to 1 flying at 1.3 times the stall speed (2:3), and

(f) verify that the idle-thrust, minimum-sink rate is not more than 240 feet per minute (fpm).

Objectives (a) through (f) were accomplished; however, not all the requirements of Ref. 2 were met.

Takeoff ground run performance was evaluated at Peterson Air Force Base and standardized to a maximum gross weight of 1,760 pounds and a density altitude of 10,000 feet. The validation requirement is that the aircraft take off under no-wind conditions at 10,000 feet density altitude from a dry, hard surface in 1,000 feet of less (1:2). Using the takeoff technique recommended by the Operating Handbook, the aircraft takeoff ground run was found to be 1,110 feet. Other techniques, such as higher takeoff speeds and full aft stick takeoffs, resulted in

higher ground runs. The aircraft does not satisfy the maximum 1,000 feet takeoff ground run requirement. See Table A2 for a summary of takeoff data obtained.

Climbs

Climb data was to be obtained at 7,000, 8,000, 9,000, and 10,000 feet pressure altitudes; however, due to time constraints, data was obtained only at 7,000 and 10,000 feet pressure altitudes. The validation requirement is that the aircraft achieve a rate of climb of at least 400 feet per minute at 10,000 feet density altitude (2:2). Figures A1 and A2 in Appendix A show rates of climb data for 7,000 and 10,000 feet, respectively. At 10,000 feet, with the data standardized to the maximum certified gross weight of 1,760 pounds, the maximum rate of climb is 588 feet per minute at an indicated airspeed of 70 miles per hour (mph). At 7,000 feet the maximum rate of climb is nearly 800 fpm at 65 mph. Due to the narrow airspeed range between the maximum rate of climb airspeed and the stall speed, insufficient data was obtained to determine best angle of climb at either altitude. While the aircraft meets the validation requirement for rate of climb at 10,000 feet, the airspeed for maximum rate of climb for both altitudes evaluated was between 65 and 70 mph. The maximum rate of climb airspeed recommended in the Operating Handbook (3:4-2) is 64 mph. Consideration should be given to amending the Operating Handbook to indicate 68 mph for maximum rate of climb (R1).

Cruise

Level flight performance of the aircraft was not evaluated and was not addressed in the validation requirements found in ASD's "Statement of Work." Future mission requirements of the aircraft may dictate that more detailed cruise data than that found in the Operating Handbook be provided. The cruise data in the Operating Handbook should be validated in order to assure that future mission requirements can be satisfied (R2).

Descents

Glides were performed with the throttle at idle with airbrakes retracted and with airbrakes extended. Engine-off glides were accomplished with the airbrakes retracted only. Validation requirements are that the aircraft have an idle thrust glide ratio of at least 20 to 1, an idle thrust minimum sink rate of not more than 240 fpm, and an approach glide ratio with airbrakes fully extended not flatter than 7 to 1 flying at 1.3 times the stall speed (2:3). According to Figure A3, which shows the idle power, airbrakes retracted performance polar, the aircraft demonstrated a maximum glide ratio of nearly 24 to 1 at an indicated airspeed of 63 mph. This exceeds the minimum 20 to 1 glide ratio required. The minimum sink rate, however, was found to be 276 fpm, which exceeds the 240 fpm requirement. This higher sink rate is not considered significant. In the approach configuration, with airbrakes fully extended and throttle at idle, the aircraft was flown at an indicated airspeed of 70 mph. As shown in Figure A4, the Aircraft has a glide ratio of 7.6 to 1, which is flatter than the 7 to 1 required. This was not

objectionable. The aircraft exhibits satisfactory handling characteristics in the approach configuration, which will be discussed further under the Operational Handling section of this report.

Although a validation requirement was not specified for power-off glides, these were performed in order to verify the power-off performance polar presented in the Operating Handbook (3:5-5). At an indicated airspeed of 60 mph, the manufacturer advertises a power-off maximum glide ratio of nearly 23 to 1. Data shown in Figure A5, derived from flying power-off glides using two different aircraft (N31AF and N32AF) standardized to 1,760 pounds, reveals an average maximum glide ratio of only 19 to 1 at 57 mph indicated airspeed. The manufacturer's data appears to be optimistically high, showing a higher maximum glide ratio at a slightly higher airspeed. The minimum sink speed, referring to Figure A5, occurs below the stall speed. The Operating Handbook should be amended to show the more conservative performance polar shown in this figure. In addition, the throttle idle performance polars for both airbrake configurations should be added to the Operating Handbook (R3).

The aircraft displays satisfactory performance characteristics for most areas evaluated. However, it did not meet the takeoff ground run requirement, the minimum sink rate requirement, or the approach glide ratio requirement. Failure to satisfy these requirements was not considered objectionalbe and

did not detract from the overall performance capability of the aircraft.

3. Flying Qualities

The objectives of the flying qualities phase of the validation program were to

(a) verify the one "g" stalling speed, V_S, between 35 and 45 mph calibrated airspeed with engine idle for both airbrakes retracted and airbrakes extended configurations,

(b) evaluate stall characteristics and stall warning in wings level and turning flight,

(c) evaluate the spin susceptibility of the aircraft,

(d) compare control inputs for both dual and solo flight,

(e) evalute trim changes in making the transition from full power to idle and in making the transition from airbrakes retracted to airbrakes extended,

(f) qualitatively compare longitudinal and lateral-directional control forces of the SGM 2-37 with those of the SGS 2-33 sailplane,

(g) qualitatively compare all control displacements of the SGM 2-37 with those of the SGS 2-33 sailplane, and

(h) investigate dynamic stability characteristics.

Most of the objectives mentioned above were accomplished. The only requirement not met was the one "g" stalling speed, V_S, between 35 and 45 mph.

Stalls

All stall entries were initiated from a trimmed condition of 70 mph followed by a 2 mph/second bleed rate down to the stall speed. Three power settings were used: power-as-required for level flight, idle-power, and power-off. Aircraft N31AF was flown during all power-as-required and idle-power stall evaluations, and N32AF was flown for all power-off stalls. The center of gravity was at 24.5 percent of the mean aerodynamic chord (MAC) for all stall investigations made using N31AF and at 22.7 percent MAC for those made using N32AF.

The results of all wings-level stall evaluations are shown in Table I.

Table I

WINGS LEVEL STALL SPEED SUMMARY

W_{STD} = 1,760 lbs

Power Condition			Airbrakes		Stall Warning (mph)	Stall (mph)
AR	Idle	Off	R	E		
X			X		--	48
X				X	--	52
	X		X		55	53
	X			X	59	55
		X	X		56	54
		X		X	60	54

AR ~ as required for level flight 70 mph

R ~ retracted

E ~ extended

With power-as-required, the aircraft exhibits no stall warning regardless of airbrake position. However, in this power configuration the aircraft demonstrated its lowest stall speed of 48 mph with airbrakes retracted. This airspeed agrees with the Operating Handbook value (3:5-4); nevertheless, it does not meet the requirement as stated in Ref. 2 for a stall speed between 35 and 45 mph (2:2 and 3). Stall speeds for idle-power and power-off with airbrakes retracted are five to six mph higher than the stall speed for power-as-required. As expected, stall speeds with airbrakes extended are generally higher than for airbrakes retracted. Stall warning occurred in the form of a mild airframe buffeting during the power-idle and power-off stall entries. Airspeeds for stall warning were highest with the airbrakes extended for these two power settings and occurred six mph above the stall speed. The condition defining the stall in all cases was an uncommanded rolling motion that for power-off stalls occurred to the left and for the other power configurations generally occurred to the right.

Controllability investigations were performed during wings-level stall entries for both airbrake configurations. The aircraft exhibits satisfactory three-axis control down to within five mph of the stall speed. As soon as elevator back pressure is released at the stall, roll and yaw control are restored. During recoveries from all stalls, power was not adjusted but airbrakes were retracted. The smallest altitude loss from stall to recovery occurred with power-as-required and airbrakes

retracted. Pullup from all stalls can be initiated after rolling wings level by using a 1.5 load factor ("g") pullup between 60 and 65 mph. If recovery is delayed, airspeed may increase rapidly to as high as 100 mph, necessitating the use of airbrakes during the pullup. Care should be taken during all high speed stall recoveries above 86 mph so that structural limitations are not exceeded (R4).

Turning stalls were performed for power-as-required and power-idle throttle configurations using bank angles from 20 to 45 degrees in both left and right turns. Entries were started from a wings level trim condition of 70 mph from which a turn was initiated with a simultaneous bleed rate of airspeed at two mph/second. Data obtained from aircraft N31AF on 5 May 1983 is shown in Figure 4, along with the Operating Handbook chart of stall speed vs. angle of bank (3:5-4). In all cases the stall is again defined by an uncommanded rolling motion. No perceived stall warning was noticed during any of the entries. In addition, the aircraft does not exhibit a consistent tendency to roll off in a particular direction regardless of bank angle. Steeper recoveries at higher airspeeds than with wings level entries were observed following all turning stalls. Dive angles were as steep as 60 degrees following the roll off at the stall speed.

See Appendix D, "Initial Flight Test Reports," dated 5, 19, and 27 May 1983 for more details concerning stall evaluations of the aircraft.

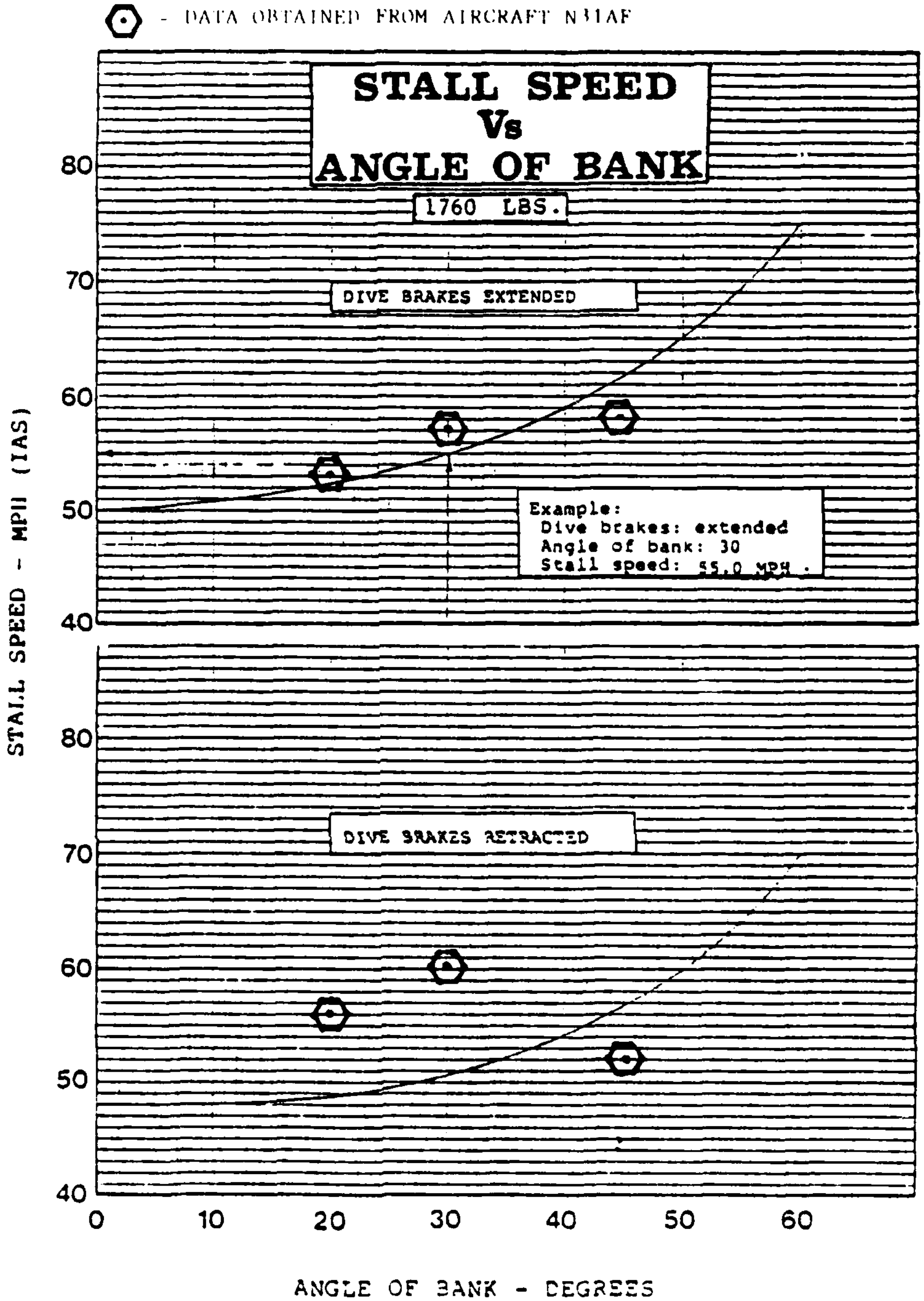


Figure 4. Stall Speed vs. Angle of Bank (3:5-4)

Spin Susceptiblity

Evaluation of spin susceptibility was performed with idle-power and pro-spin controls (full aft stick and full rudder) held for three seconds. Each of the entries evaluated was initiated from a trim airspeed of 70 mph at altitudes between 12,000 and 12,500 feet. A bleed rate of two mph/second was initiated from the trim condition with pro-spin controls applied at the first indication of the stall. Both wings-level and 20-degree-bank turning entries were performed in both airbrakes-retracted and airbrakes-extended configurations.

As discussed earlier, all stalls were characterized by an uncommanded angular motion, i.e., drop off on a wing. Generally, the aircraft tended to drop off on the right wing during straight ahead entries and in the direction of the turn during turning entries. Once the aircraft enters the post stall gyration with the three-second application of pro-spin controls, the motion is characterized by more roll than yaw along with a 60-degree, nose-down pitch attitude. The aircraft made from one to one and a quarter turns from entry to recovery. Airbrakes may be required to avoid excessive airspeed buildup and altitude loss. Since all recovery airspeeds exceeded the aircraft's maneuvering speed of 86 mph, care should be taken during the pullout not to exceed aircraft structural limits (R5). The recovery technique used was neutral aileron and opposite rudder followed by bringing the stick approximately one inch off the back stop. Generally, the aircraft recovered within one-fourth to one-half turn.

Rudder was not effective in stopping the yaw until forward elevator was applied. Post stall gyrations with airbrakes extended resulted in shallower pitch attitudes than with airbrakes retracted. For all the entries performed, the altitude loss was between 500 and 1,000 feet with recovery airspeeds from 90 to 100 mph. No unusual control problems during recoveries were encountered; however, the aircraft is susceptible to spins with a three-second pro-spin application of the controls.

More details on the spin susceptiblity evaluation are contained in the "Initial Flight Test Report" dated 5 May 1983 in Appendix D.

Trim Changes and Solo Flight Control

Trim changes using rapid throttle movements and airbrake changes were evaluated from an initial trimmed-flight condition at 65 mph. No longitudinal or lateral-directional moments were experienced that required a trim change for either large-throttle changes or full-airbrake applications.

The aircraft was flown solo once during the validation program in order to accommodate an oxygen system in the left seat. Handling qualities for all flight phases were found to be identical to those experienced during dual flight.

Longitudinal and Lateral-Directional Static Stability and Control

Longitudinal stability was quantitatively evaluated by measuring stick force and stick displacement from a trimmed condition of 70 mph with airbrakes retracted. Two areas of

longitudinal stability were examined: static longitudinal stability and maneuvering flight. The objective was to qualitatively compare the longitudinal control characteristics of the SGM 2-37 with those of the SGS 2-33.

Static longitudinal stability was evaluated by changing airspeed from the trimmed 70 mph condition by using pitch control. Two data runs were performed, one with throttle idle and one with power-as-required for level flight. Airspeed was decreased to as slow as 55 mph and increased to as high as 90 mph. The results are shown in Figure A6. Force and displacement gradients were not objectionable. Only slightly more stick force was required with idle power than with power-as-required. This is probably due to prop wash effects on the horizontal tail.

Maneuvering flight characteristics were evaluated from the same 70 mph trim condition but with the throttle at idle only. The flight technique used here consisted of varying load factor while descending to maintain a constant 70 mph airspeed. A plot of stick force and stick displacement versus load factor is shown in Figure A7. Again, the stick force and displacement gradients were not objectionable. Stick force per unit load factor was 12 pounds/"g".

The SGM 2-37 demonstrates satisfactory longitudinal control for both static and maneuvering flight. Qualitatively, the SGM 2-37 has slightly higher longitudinal control force with much less longitudinal stick displacement than does the SGS 2-33.

Lateral-directional static stability was generally evaluated only qualitatively because of time constraints and lack of instrumentation. Using the magnetic compass as a sideslip angle reference, the maximum sideslip generated at 70 mph was approximately 25 degrees in both directions with only five degrees of bank. Roll control was also evaluated at 70 mph by rolling through 90 degrees of bank: 45 degrees bank in one direction to 45 degrees in the other direction. This was accomplished using one-half and full aileron deflection in both directions, with rudder-free and rudder-coordinated control applications. See Table II for the results.

Table II

AILERON ROLLS

Altitude - 9,000 Feet

Airbrakes Retracted

$V_i)_{trim}$ = 70 mph

δ_A	δ_R	Time (SEC)
1/2	FREE	9.3
FULL	FREE	4.8
1/2	COORDINATED	7.5
FULL	COORDINATED	5.1

As expected the highest roll rate occurred with full aileron rolls; however, almost no difference in time to roll was measured when rolling with the rudder free as opposed to with the rudder coordinated. The biggest difference in roll rate between rudder free and rudder coordinated rolls occurred with one-half aileron. Adverse yaw effects are also more noticeable with one-half aileron. In general, the aircraft exhibits little requirement for rudder in a turn. Only slightly more rudder is required for coordinated left turns compared to coordinated right turns, due to control rigging for engine torque. In fact, for takeoff power operation, engine torque effects requiring right rudder are nearly eliminated by control rigging.

A qualitative comparison of the lateral-directional control of the SGM 2-37 to that of the SGS 2-33 shows that rudder forces and requirements for rudder are totally different. Aileron force is slightly higher and aileron control displacement is less in the SGM 2-37 than in the SGS 2-33.

Even though the handling qualities of the SGM 2-37 are different from those of the SGS 2-33 for control about all three axes, control harmony in the SGM 2-37 is excellent. Elevator and aileron forces appear to be comparable, and rudder force is under 50 pounds for all operations.

Dynamic Characteristics

The dynamic characteristics of the SGM 2-37 were evaluated from a trim condition of 70 mph, airbrakes retracted, and power-as-required for level flight at 9,000 feet. The phugoid and

short-period longitudinal dynamic modes and the spiral and Dutch-roll lateral-directional dynamic modes were evaluated.

The aircraft is dynamically stable for both of the longitudinal modes evaluated. The short period is highly damped with a damping ratio greater than .7. The phugoid, shown in Figure A8, is stable with a damping ratio of .094 and an actual frequency of 2.3 cycles per minute.

Evaluating lateral-directional dynamic stability, the SGM 2-37 exhibited a stable Dutch roll and an unstable spiral to the left. After exciting the Dutch roll, the aircraft motion revealed more yaw than roll and damped out after only four overshoots. The Dutch roll damping ratio was .3 and the actual frequency was 13.1 cycles per minute. The spiral mode was stable to the right with the aircraft rolling wings-level from a right bank of 20 degrees. However, the aircraft exhibited an unstable spiral to the left by rolling from an initial 20 degrees of left bank to over 40 degrees of bank to the left in 20 seconds. This is due to the lateral center of gravity location caused by the fuel tank in the left wing and due to the torque effects of the engine. Spiral instability to the left was not objectionable.

4. Operational Handling

This section of the report is an overall assessment of the capability of the SGM 2-37 aircraft to fulfill its mission requirements. Much of the operational handling evaluation is of necessity qualitative in nature and deals with cockpit and preflight observations, ground handling, and general flight

operations. The opinions expressed in the following paragraphs may not be shared by all of the pilots who have flown the aircraft.

<u>Cockpit and Pre-Flight Observations</u>

Generally speaking, the cockpit layout is both simple an practical (see Figure 2). If the two crew members sitting side by side are taller and/or heavier than average, the cockpit may be somewhat cramped. However, all controls are easily accessible to both crew members under normal circumstances. Rudder pedals are adjustable, although the seats are not.

Location of the pilot's microphone mount on the right side of the cockpit was found to be unsatisfactory. When it was moved to the instrument panel of N31AF during the validation program, it was much easier to handle. This should not be a problem in the future, since all aircraft will eventually be modified with headsets.

Perhaps the most serious problem with the cockpit is the proximity of the left-side airbrake handle to the pilot in the left seat. In this position it comes into contact with the student pilot's leg during retraction and extension. As shown in Figure 5, this becomes an even more significant problem with full left aileron throw and simultaneous airbrake extension or retraction. The airbrake handle for the left seat should be modified to prevent interference with the left seat pilot's leg and an interim WARNING should be added to the <u>Operating Handbook</u> (R6):


Airbrake Handle being Retracted
Full Left Aileron Deflection

WARNING

Simultaneous requirement for full left aileron and airbrake extension or retraction may not be possible due to contact beween the control and the left-seat occupant's leg.

Some of the pilots who flew the aircraft felt that modification of the control sticks in both seats was also necessary. The stick contacts the seat cushion and the pilot during full aft stick application. Moving the stick forward approximately two inches, possibly by means of an "S" bend, would allow freer aft stick movement for the pilots in both seats (R7).

Shoulder straps in both seats need an inertial reel to allow greater forward motion by crew members (R8). With the shoulder harness secure, the defroster ducts on the glare shield cannot be reached. *While not a serious problem*, inertial reels would enhance comfort and render all parts of the cockpit accessible to both crew members.

During pre-flight, crew members had a tendency to grab the canopy when entering or exiting the cockpit. The canopy structure is not designed to be a handhold. The following CAUTION should be added to the Operating Handbook (R9):

CAUTION

The canopy should not be used as a handhold when entering

or exiting the aircraft due to the possibility of warping the canopy frame and causing it to bind in the track.

To facilitate checking the fuel tank sump and opening the fuel cap, a general aviation fuel tester with a screw driver end should be obtained for each powered sailplane (R10).

When aircraft N31AF was weighed on 3 May 1983, it was discovered that, with a full fuel load and two crew members on board, the airplane exceeds the 1,760-pound maximum gross weight limit. Table III shows the results of the weight and balance performed on 3 May.

Table III

WEIGHT AND BALANCE FIGURES FOR N31AF

Scale Position	Scale Readings (lbs)	(-)Tare	(=)Weight (lbs)
Left Wheel	732	3.0	729
Right Wheel	628	3.0	625
Tail Wheel	61	0.0	61
Total Weight with Full Fluids	--	--	1415

C.G. Arm (In.) (without crew) $= \frac{61\ (232.0")}{1415} + (75.0") = 85.00"$ from the datum

Table III (Continued)

Validation Crew Weight	364
Total T.O. Weight	1779*

C.G. Arm (In.) = 83.23" from the datum
(with crew)

*Aircraft is 19 pounds overweight.

With the validation flight crew on board, a full oil and fuel load, and some added instrumentation, the aircraft weighs 1,779 pounds. However, according to the applicable part of the "Statement of Work," the aircraft still meets ASD's contract requirement. The contract reads

> "With sufficient fuel to accomplish at least three of the most severe sorties, the powered sailplane shall be capable of carrying 420 pounds of pilots, parachutes, and seat cushions." (2:3)

The most severe sortie involves a 45-minute flight. Using a conservative fuel flow of 4.5 gallons per hour and zero reserve for three 45-minute sorties, the aircraft only requires approximately 10 gallons of fuel. Using the weight-and-balance figures provided by Schweizer for N31AF along with the contract payload of 420 pounds, the aircraft weighs 1,759.5 pounds. There is absolutely no weight margin to allow for operating the aircraft with a full fuel load along with the 420 pound contract payload. In addition, the fuel indicating system is not sufficiently accurate to allow a partial 10-gallon refueling. An

increase of at least 50 pounds in certified gross weight is needed in order to easily accommodate a full fuel load along with varied combinations of crew weight (R11). Since the 50-pound increase represents only a three percent increase in wing loading, the Federal Aviation Administration (FAA) may not require drop testing for re-certification. Ideally, a weight increase of 100 pounds would allow more flexibility for future modifications and uses of the aircraft. This, however, may require drop testing and could delay the delivery schedule for the rest of the Academy's SGM 2-37 fleet. At this time, the 50-pound weight increase appears adequate. See Appendix B for more information on weight-and-balance considerations for the aircraft.

As mentioned above, the fuel indicating system is not sufficiently accurate to allow partial refueling for specific fuel loads. On the ground with the tank visually filled to capacity, the fuel quantity gauge indicates that it is only three-quarters full. This situation existed on both the aircraft flown during the validation program. The fuel indicating system should be recalibrated to show full on the ground with the fuel tank filled to capacity (R12).

Ground Handling

Forward visibility during taxi operations is surprisingly good for a tail dragger. The tail wheel affords adequate control during turns for most situations and is controlled in a conventional manner through the rudder pedals. However, loss of

directional control can occur during sharp or rapid turning maneuvers. Under these circumstances, the tailwheel may disengage from the steering system. The following WARNING with Note should be added to the Operating Handbook (R13):

WARNING

Sharp or rapid turning maneuvers during taxi operations should be avoided, since the tailwheel may disengage from the steering system, resulting in loss of directional control.

Note

Differential braking does not seem to be particularly effective under all conditions.

While the aircraft is not especially difficult to taxi during gusty wind conditions due to the low wing design, the high aspect-ratio wing is sensitive to strong crosswings. To enhance ground handling and avoid potential damage to the aircraft, the airbrakes should be extended during all taxi operations (R14).

General Flight Operations

The aircraft was qualitatively evaluated in the traffic pattern, in cruise conditions, in the power-off configuration along with engine-airstart capability, and during high altitude powered operation to 18,000 feet mean sea level (MSL).

Takeoff characteristics of the aircraft were evaluated both with and without crosswinds. With calm winds, takeoffs were

performed at 52 mph using the normal takeoff technique. In addition, several takeoffs were performed at 55 and 60 mph by applying forward stick force to keep the aircraft on the runway, and two takeoffs were performed with full aft stick. In all cases, the trim was set at the takeoff trim setting designated on the cockpit trim wheel scale. When the normal takeoff technique at 52 mph was used, the tail began flying at 40 to 42 mph with only slight aft stick required for lift off at 52. This is the Operating Handbook procedure and worked well. As the tail lifts off between 40 and 42 mph, rudder is effective for directional control. At 55 and 60 mph, forward stick was applied after the tail began flying in order to keep the aircraft on the runway. This technique resulted in longer ground runs and exposed the prop to possible damage from debris on the runway. During the two aft-stick takeoffs performed, close to 50 pounds of aft-stick force was required to keep the tail on the ground. The aircraft lifted off in a three-point attitude at 52 mph with a slightly longer takeoff ground run than that produced by the normal Operating Handbook technique (see Table A2). With the full aft stick technique, not only is stick force excessive, but pitch attitude is also higher and acceleration after lift-off is slower. This puts the aircraft close to its stall speed for a longer period of time after lift-off, which could be disastrous in gusty wind conditions. In addition, releasing back pressure immediately after lift-off may cause the aircraft to contact the runway again if done too abruptly. For calm or moderate wind

conditions, the normal Operating Handbook takeoff technique is best. For takeoff into strong crosswinds up to 15 knots, crosswind controls need to be applied before beginning the takeoff roll. In order to avoid a large increase in required rudder during crosswind takeoffs as the tailwheel lifts off the runway, the tail should be kept on the runway until 45 to 50 mph (R15). The following CAUTION should be added to the Operating Handbook (R16):

CAUTION

Improper crosswind control application during the initial part of the takeoff roll may result in the aircraft's weathervaning into the wind so that differential banking and/or tailwheel steering may be ineffective in preserving directional control. The only way to avoid running off the runway under these conditions is to abort the takeoff.

In the traffic pattern, during approaches, the aircraft was flown at 65 and 70 mph with variations in airbrake and throttle technique. Of all the approach techniques evaluated, an approach at 70 mph, throttle idle, using airbrakes as required, provided the most glide-path and airspeed control. Full airbrakes were extended at touchdown, which is a technique that the cadets will see when making the transition to the SGS 2-33 sailplane. Approaches with full airbrakes and idle power were satisfactory

but resulted in steeper approaches with a larger pitch change required in making the transition to a landing attitude. Using this technique, rounding out high without the benefit of ground effect can result in hard landings. With full airbrakes, the aircraft exhibits little tendency to float in ground effect. Approaches flown with idle power and no airbrakes revealed that the aircraft will float in ground effect down to the stall speed resulting in excessive landing distance. Sideslipping the aircraft, however, is effective in losing altitude under these conditions. When approaches were made with full airbrakes and power-as-required to maintain airspeed, glide paths were shallow and the SGM 2-37 was flown much like a conventional powered aircraft. Throttle was retarded to idle approaching the landing threshhold followed by a normal transition to flare and landing. All these approach techniques were repeated for an approach airspeed of 65 mph. The controls felt more sluggish at 65 mph, and less airspeed margin for recovery from a high roundout during landing was provided. This airspeed was determined to be too slow for all the approach techniques evaluated. Surprisingly, the Operating Handbook recommends a 60 mph minimum approach speed (3:4-23 and 4-24). Minimum approach speed for landing should be 70 mph (R17).

The SGM 2-37 was flown in crosswinds up to 15 knots at both 65 and 70 mph. All of the approach techniques discussed above were performed. In all cases, the normal wing low into the wind with opposite rudder procedure was used. Again, approaches at 70

mph were far more controllable. In strong crosswinds with gusty conditions, the power-on, full airbrakes technique afforded more directional control and easier transition to a landing attitude. Touchdowns during crosswind landings should be made at higher than normal airspeeds to enhance directional control. The tailwheel should then be lowered to the runway as soon as possible to avoid loss of rudder effectiveness as the aircraft slows after touchdown (R18).

Engine operation for all flight conditions is excellent. Effective leaning is provided by pulling the mixture lever back to the screw stop. This can increase rate of climb by approximately 100 fpm. This procedure also works well for takeoff in order to achieve maximum engine power. The only potential problem with engine operation was observed during cruise with full throttle. At altitudes flown from 7,000 to 18,000 feet, the engine rpm will exceed the maximum rated value of 2600 rpm as the airspeed reaches 90 mph with full throttle. The following CAUTION should be added to the Operating Handbook (R19):

CAUTION

Care should be taken not to exceed the maximum rated rpm of 2600 during level-flight, full-throttle operation. This normally occurs at airspeeds approaching 90 mph.

A problem with the fuel gauge, mentioned during the pre-flight discussion, also exists during flight operations. During climb, cruise, and descent, the fuel quantity gauge is erratic and does not give an accurate indication of remaining fuel. An alternate fuel quantity gauge should be installed or the existing gauge should be modified so that reliable readings of fuel remaining in-flight can be obtained (R20).

The only specific operational requirement for the SGM 2-37 is that it be capable of powered operation at altitudes as high as 18,000 feet MSL (2:2). On 23 May 1983, N31AF was flown solo, with an oxygen system secured in the left seat, to an altitude of 18,000 feet. The time from takeoff to altitude was 26 minutes at a nominal gross weight of 1,640 pounds. Airspeed throughout the climb was 64 mph, the Operating Handbook-recommended best rate of climb speed (3:2-3). Engine indications remained normal throughout the climb with an average engine rpm of 2350. Vertical velocity ranged from 600 fpm passing 10,000 feet to 350 fpm at 18,000 feet. The maximum level-flight airspeed was determined to be 90 mph at 18,000 feet. The service ceiling, based on a linear extrapolation of rates of climb from 10,000 to 18,000 feet, is approximately 26,000 feet. Not only is the aircraft very capable of high altitude operation up to and including 18,000 feet, but it also has the potential to operate at high altitude as a routine part of a normal mission profile. Current mission requirements dictate operation only as high as 12,000 feet.

Power-off operation of the aircraft was evaluated on two separate flights, first in N31AF and then in N32AF. This was accomplished in N31AF during glides from 18,000 to 9,000 feet and in N32AF during glides from 12,000 to 9,000 feet. In addition, power-off glides in the traffic pattern to landing were performed in N32AF. During power-off glides in both aircraft, the SGM 2-37 performed and handled with a noticeably lower glide ratio than during power-on. Comparing Figures A3 and A5 substantiates this observation. However, in the traffic pattern the characteristics of the aircraft during power-off operation seemed similar to those exhibited when flying the aircraft with the throttle at idle. All engine-out patterns were flown at 70 mph with sink rates nearly the same as those observed for throttle-idle pattern work. Starting from the normal USAF Academy sailplane entry point at 7,500 feet MSL and 70 mph, full airbrakes were used on base, partial airbrakes turning base to final, partial airbrakes on final, and full airbrakes at touchdown. Rates of sink appear to be about twice what they are in SGS 2-33. In summary, the aircraft has good handling characteristics power-off, but with a noticeably lower glide ratio. If power-off airwork is incorporated as part of either pilot instructor training or cadet training, the mixture lever should be left in full rich, fuel pump on, throttle set above the idle position, and magneto switch on in order to facilitate rapid engine starts if required (R21). This is particularly important in the traffic pattern.

Engine shutdowns were accomplished at 18,000, 12,000, 10,000, and 9,000 feet. In all cases, the time for the propeller to come to a complete stop was decreased by slowing the aircraft to 55 mph. The prop usually stopped in the horizontal position, which is desired for better forward visibility.

Engine starts were performed between 9,000 and 10,000 feet by using the electric starter and by windmilling the propeller. During all propeller windmilling restarts, the prop began turning between 100 and 115 mph. This method of engine start is effective and avoids frequent use of the electric starter; however, at least 500 feet of altitude may be required to achieve prop windmilling airspeed. During all starts using the electric starter system, the engine normally turned over two to three times before starting. No priming was required, and the mixture was set at full rich until start and then leaned. Starting from the published Operating Handbook minimum sink airspeed of 59 mph, only 300 feet of altitude were lost from the time the engine start checklist was initiated to completion of the engine start sequence.

During all engine-out and throttle-idle airwork the altimeter indicator has a tendency to hang up passing its 12 and 6 o'clock positions. This problem was worse during engine-out operation. For both power configurations, the altimeter lag is approximately 100 to 200 feet. The following Note should be added to the Operating Handbook (R22):

Note

Altimeter lag of 100 to 200 feet along with hang up at the 6 and 12 o'clock positions on the indicator will occur during throttle-idle and power-off flight operations.

During one sortie in which a typical cadet mission profile was flown, the aircraft satisfied all mission requirements within the planned 45 minutes of flying time. Mission events consisted of a climb to 12,000 feet, glides, discussion of control effectiveness along with attitude flying, two approaches to the auxilliary field, and, finally, a climb back to altitude followed by a full stop landing at the USAF Academy Airfield. All glides were performed with the throttle at idle. Momentary throttle bursts were performed at 30 second intervals to prevent spark plug fouling. The engine manufacturer should be contacted to determine the exact requirements for clearing the engine during extended flight operations with the throttle at idle (R23).

III. Conclusions and Recommendations

Verification of the SGM 2-37's capabilities was accomplished through a flying validation program conducted in three phases: performance, flying qualities, and operational handling. Eleven data sorties were flown for a flying time of 19 hours. Most of the objectives of the validation program as defined in ASD's "Statement of Work" were met, with the exception of climb

performance at 8,000 and 9,000 feet and flight evaluations with the aircraft center of gravity at the aft limit. Generally speaking, the SGM 2-37 powered sailplane is entirely capable of fulfilling its mission requirements and should prove to be an outstanding addition to the USAF Academy's Soaring Program.

A. Pitot-Static Calibration

Using a 1.7 statute-mile ground course and airspeeds from 55 to 110 mph, the position error of the pitot-static system was found to be negligible, and data obtained agreed with that found in the Operating Handbook. In addition, no measurable difference in position error was found by flying the aircraft in different airbrake configurations.

B. Performance

Using the takeoff technique recommended by the Operating Handbook, the takeoff ground run for 10,000 feet density altitude was found to be 1,110 feet. The aircraft does not satisfy the maximum 1,000 feet takeoff ground run requirement of Ref. 2.

With data standardized to a maximum certified gross weight of 1,760 pounds, the aircraft's maximum rate of climb at 7,000 feet is 800 fpm at 65 mph and at 10,000 feet is 588 fpm at 70 mph. While the aircraft meets the validation requirement for 400 fpm at 10,000 feet, the airspeed for maximum rate of climb from

7,000 to 10,000 feet is from 65 to 70 mph. The Operating Handbook-recommended maximum rate of climb airspeed is 64 mph.

(1) Consideration should be given to amending the Operating Handbook to indicate 68 mph for maximum rate of climb (p. 10).

Level-flight performance of the aircraft was not evaluated. Future mission requirements of the aircraft may dictate more detailed cruise data than that found in the Operating Handbook.

(2) The cruise data in the Operating Handbook should be validated to insure that future mission requirements can be satisfied (p. 11).

For idle power with the airbrakes retracted, the aircraft has a maximum glide ratio of nearly 24 to 1 at an indicated airspeed of 63 mph. This exceeds the required 20 to 1 glide ratio stated in Ref. 2. The minimum sink rate, however, was found to be 276 fpm, which exceeds the requirement for a maximum sink rate of 240 fpm. With the throttle at idle and airbrakes fully extended, flying at 70 mph, the aircraft has a glide ratio of 7.6 to 1, which exceeds the maximum glide ratio of 7 to 1 stated in Ref. 2. With power-off and airbrakes retracted, the aircraft has a maximum glide ratio of only 19 to 1 at 57 mph. The manufacturer's Operating Handbook data for power-off indicates a maximum glide ratio of nearly 23 to 1 at 60 mph. The manufacturer's data appears to be too high, showing a higher maximum glide ratio at a slightly higher airspeed.

(3) The Operating Handbook should be amended

to show the more conservative performance polar shown in Figure A5. In addition, the throttle idle performance polars for both airbrake configurations should be added to the Operating Handbook (p. 12).

The aircraft failed to meet the maximum takeoff ground run requirement, the minimum sink-rate requirement, and the approach glide ratio requirement. Failure of the aircraft to satisfy these requirements was not considered objectionable and did not detract significantly from the overall performance capability of the aircraft.

C. Flying Qualities

With the throttle set for power-required for level flight, the aircraft exhibits no stall warning regardless of airbrake position. In this throttle configuration the aircraft demonstrated its lowest wings-level stall speed of 48 mph with the airbrakes retracted. This speed agrees with the Operating Handbook; however, it fails the stall requirement as stated in Ref. 2. Stall speeds for idle power and power-off with airbrakes retracted are five to six mph higher than stalls with power set for level flight. Stall speeds with airbrakes extended are generally higher than those with airbrakes retracted. Stall warning occurred with airbrakes both retracted and extended in the form of mild airframe buffeting for both idle and power-off conditions. In all cases, the stall was defined by an

uncommanded rolling motion. The aircraft exhibits satisfactory three-axis control down to within five mph of the stall speed. The smallest altitude loss from stall to recovery occurred with power set for level flight and airbrakes retracted. If recovery is delayed, airspeed may increase to as high as 100 mph, necessitating the use of airbrakes during the pullup.

(4) Care should be taken during all high speed stall recoveries above 86 mph so that structural limitations are not exceeded (p. 16).

For turning stalls in both directions from 20 to 45 degrees of bank, the stall is again defined by an uncommanded rolling motion. Steeper recoveries at dive angles as high as 60 degrees were observed for turning stall entries as opposed to wings level entries.

Investigation of the spin susceptibility of the SGM 2-37 revealed that, with a three-second application of pro-spin controls following stall, the aircraft exhibits a post-stall gyration with more roll than yaw along with a 60-degree, nose-down pitch attitude. Airbrakes may be required during recovery to avoid excessive airspeed buildup.

(5) Since all recovery airspeeds exceeded the aircraft's maneuvering speed of 86 mph, care should be taken during pullout so as not to exceed aircraft structural limits (p. 18).

Altitude loss for all the spin-susceptibility evaluations performed was between 500 and 1,000 feet with recovery airspeeds

from 90 to 100 mph. The aircraft is susceptible to spins with a three-second, pro-spin application of the controls.

No trim requirements were generated when making the transition from airbrakes retracted to airbrakes extended or for large changes in throttle setting.

Solo handling qualities were found to be identical to those experienced during dual flight.

The SGM 2-37 demonstrates satisfactory static and maneuvering longitudinal control. However, compared to the SGS 2-33, the SGM 2-37 requires slightly more longitudinal control force with much less stick displacement.

During lateral-directional control evaluations, it was found that the SGM 2-37 exhibits little requirement for rudder in a turn. In addition, engine torque effects are essentially eliminated by control rigging. Comparing lateral-directional control of the SGM 2-37 to that of the SGS 2-33, aileron force in the SGM 2-37 is higher and control displacement less than for the SGS 2-33.

All five dynamic modes of the aircraft were found to be stable for the flight condition evaluated except for an unstable spiral to the left. This was due to a lateral center of gravity location and to control rigging. It was not objectionable.

D. Operational Handling

The aircraft satisfies all the requirements for operational handling stated in Ref. 2. No significant factors

were discovered that would have an adverse effect on the mission capability of the aircraft. The following recommendations are derived from an evaluation of cockpit and pre-flight observations, ground handling, and general flight operations.

Cockpit and Pre-Flight Observations

(6) The airbrake handle for the left seat should be modified to prevent contact between the control and the left-seat pilot's leg. An interim WARNING should be added to the Operating Handbook:

WARNING

Simultaneous requirement for full left aileron and airbrake extension or retraction may not be possible due to contact between the control and the left-seat occupant's leg (p. 24).

(7) Moving the stick forward approximately two inches, possibly by means of an "S" bend, would allow freer aft stick movement for the pilots in both seats (p. 26).

(8) Shoulder straps in both seats need an inertial reel to allow greater forward motion by crew members (p. 26).

(9) The following CAUTION should be added to the Operating Handbook:

CAUTION

The canopy should not be used as a handhold when entering or exiting the aircraft due to the possiblity of warping the canopy frame and causing it to bind in the track (p. 26).

(10) As an aid in accomplishing all the checklist pre-flight requirements, a general aviation fuel tester, with a screwdriver end, should be obtained for each powered sailplane (p. 27).

(11) An increase of at least 50 pounds in certified gross weight is needed in order to easily accommodate a full fuel load along with varied combinations of crew weight (p. 29).

(12) The fuel-indicating system should be recalibrated to show full on the ground with the fuel tank filled to capacity (p. 29).

Ground Handling

(13) The following WARNING with Note should be added to the Operating Handbook:

WARNING

Sharp or rapid turning maneuvers during taxi operations should be avoided, since the tailwheel may disengage from the steering system, resulting in loss of directional control.

Note

Differential braking does not seem to be

particularly effective under all conditions (p. 30).

(14) To enhance ground handling and avoid potential damage to the aircraft, the airbrakes should be extended during all taxi operations (p. 30).

General Flight Operations

(15) In order to avoid a large increase in required rudder during crosswind takeoffs as the tailwheel lifts off the runway, the tail should be kept on the runway until 45 to 50 mph (p. 32).

(16) The following CAUTION should be added to the Operating Handbook:

CAUTION

Improper crosswind control application during the initial part of the takeoff roll may result in the aircraft weathervaning into the wind so that differential braking and/or tailwheel steering may be ineffective in preserving directional control. The only way to avoid running off the runway under these circumstances is to abort the takeoff (p. 32).

(17) Minimum approach speed for landing should be 70 mph (p. 33).

(18) Touchdowns during crosswind landings should

be made at higher than normal airspeeds to enhance directional control. The tailwheel should then be lowered to the runway as soon as possible to avoid loss of rudder effectiveness as the aircraft slows after touchdown (p. 34).

(19) The following CAUTION should be added to the Operating Handbook:

CAUTION

Care should be taken not to exceed the maximum rated rpm of 2600 during level-flight, full-throttle operation. This normally occurs at airspeeds approaching 90 mph (p. 34).

(20) An alternate fuel quantity gauge should be installed or the existing gauge should be modified so that reliable readings of fuel remaining in-flight can be obtained (p. 35).

(21) If power-off airwork is incorporated as part of either pilot instructor training or cadet training, the mixture level should be left in full rich, fuel pump on, throttle set above the idle position, and magneto switch on in order to facilitate rapid engine start if required (p. 36).

(22) The following Note should be added to the

Operating Handbook:

Note

Altimeter lag of 100 to 200 feet along with hang up at the 6 and 12 o'clock positions on the indicator will occur during throttle idle and power-off flight operations (p. 37).

(23) The engine manufacturer should be contacted to determine the exact requirements for clearing the engine during extended flight operations with the throttle at idle (p. 38).

References

1. Crenshaw, Kent R., Limited Performance and Flying Qualities Validation of the SGM 2-37 Powered Sailplane, USAF Academy, January 1983.

2. Statement of Work, Parts I and II, F33657-81-C-0303, Headquarters, Aeronautical Systems Division, Wright-Patterson AFB, Ohio.

3. SGM 2-37 Motorglider Pilot's Operating Handbook, Schweizer Aircraft Corporation, Elmira, New York, 22 March 1983.

4. Performance Theory and Flight Test Techniques, FTC-T1H-70-1001, USAF Test Pilot School, Edwards AFB, California, January 1973.

5. Flying Qualities Theory and Flight Test Techniques, FTC-T1H-79-2, USAF Test Pilot School, Edwards AFB, California, 1 August 1979.

6. Airstrip Operations and Air Traffic Control, USAF Academy Regulation 55-4, 9 May 1980.

APPENDIX A

SGM 2-37 Sortie Summary

Graphical Data

TABLE A1.
SGM 2-37 SORTIE SUMMARY

DATE	A/C	CREW	FLT TIME (HRS)	DATA	REMARKS
4/27	N31AF	Crenshaw Picha	2.4	Pitot-Static/Trim Changes	Helicopter Photographic Support
5/3	N31AF	Crenshaw Picha	2.4	Pitot-Static	
5/5	N31AF	Crenshaw Picha	1.7	Spin Susceptibility & Stall Evaluation	UV-18 Photographic Support
5/5	N31AF	Crenshaw Picha	.9	Takeoff & Landing Evaluation	Too Gusty and Turbulent to Complete
5/9	N31AF	Crenshaw Picha	1.7	Pitot-Static/Climbs & Descents	Pitot-Static Data Complete
5/9	N31AF	Crenshaw Picha	1.3	Takeoff & Landing Crosswind Eval.	Maximum 15 Knot Crosswind
5/11	N31AF	Crenshaw Picha	2.3	Climbs & Descents	.3 for Weather Divert
5/12	N31AF	Crenshaw Taylor	.8	Normal Mission Profile	
5/19	N31AF	Crenshaw Picha	2.8	Descents & Flying Qualities	Descents with Airbrakes Extended
5/23	N31AF	Crenshaw	1.2	High Altitude Op's and Power Off Glides	Flown Solo
5/27	N32AF	Crenshaw Picha	1.5	Power Off Glides, Stalls and Landings	
		TOTALS =	19.0	hours and 11 sorties	

Table A2
TAKEOFF DATA
SGM 2-37, N31AF

W_{STD} = 1,760 lb.

Alt. = 10,000 ft.

V_i (mph) Lift-Off	Average Distance (ft.)	Number of Data Points
52	1110	3
55	1159	5
60	1158	5
52*	1218	3

*Full Aft Stick

SGM 2-37, N31AF, AIRBRAKES RETRACTED

W_{STD} = 1760 LBS

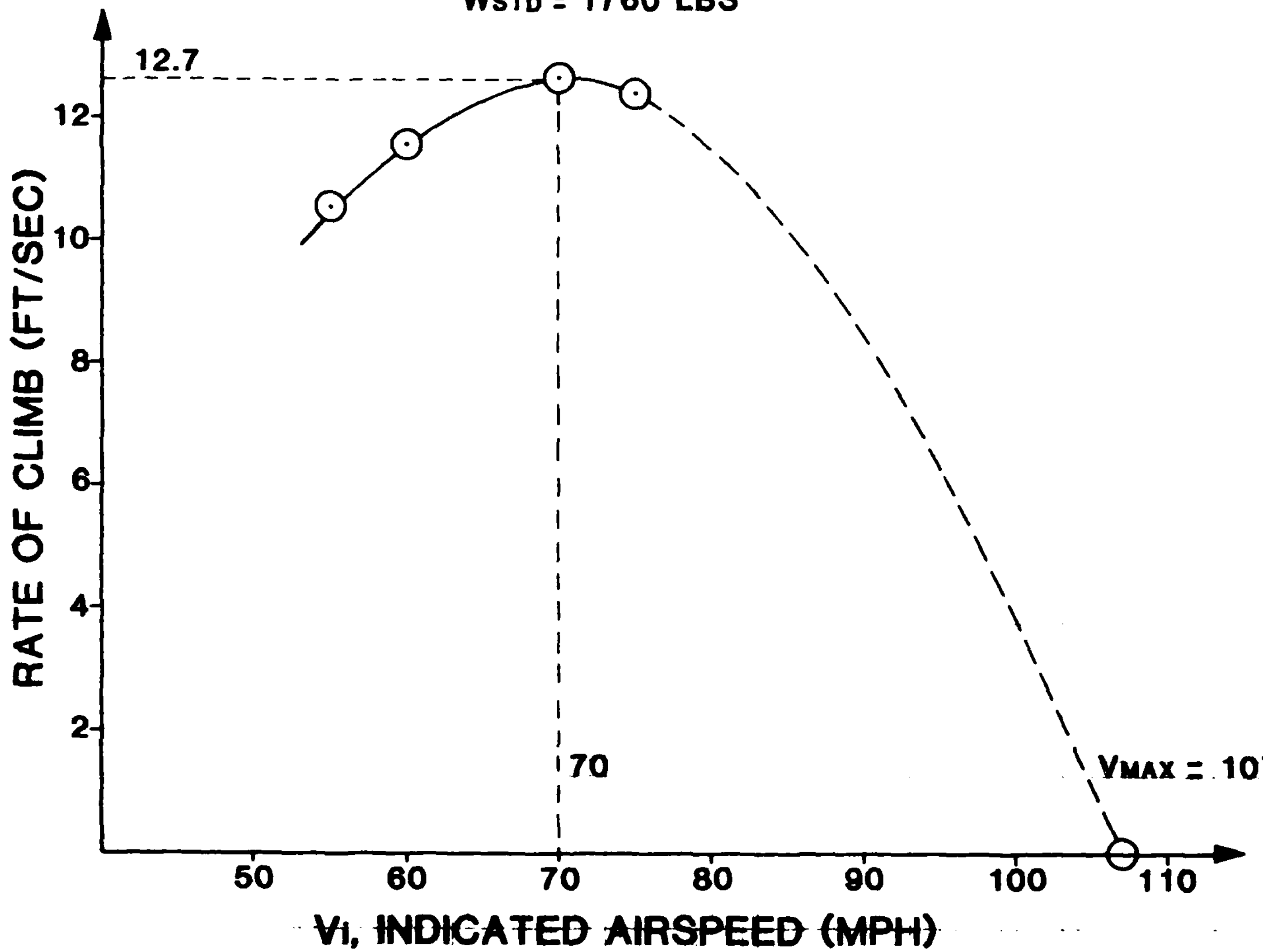


FIGURE A1. SAWTOOTH CLIMB DATA AT 7,000 FEET

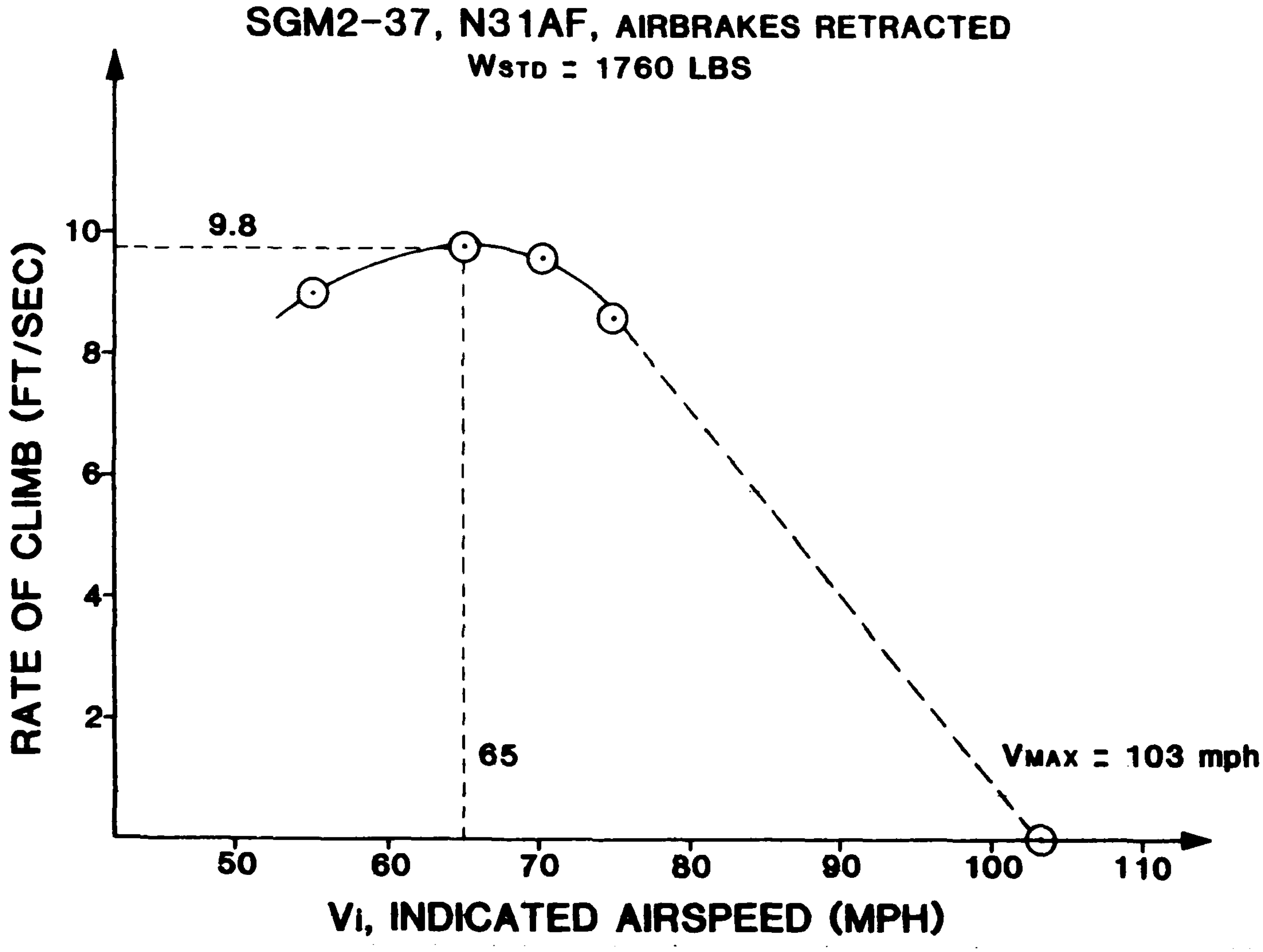


FIGURE A2. SAWTOOTH CLIMB DATA AT 10,000 FEET

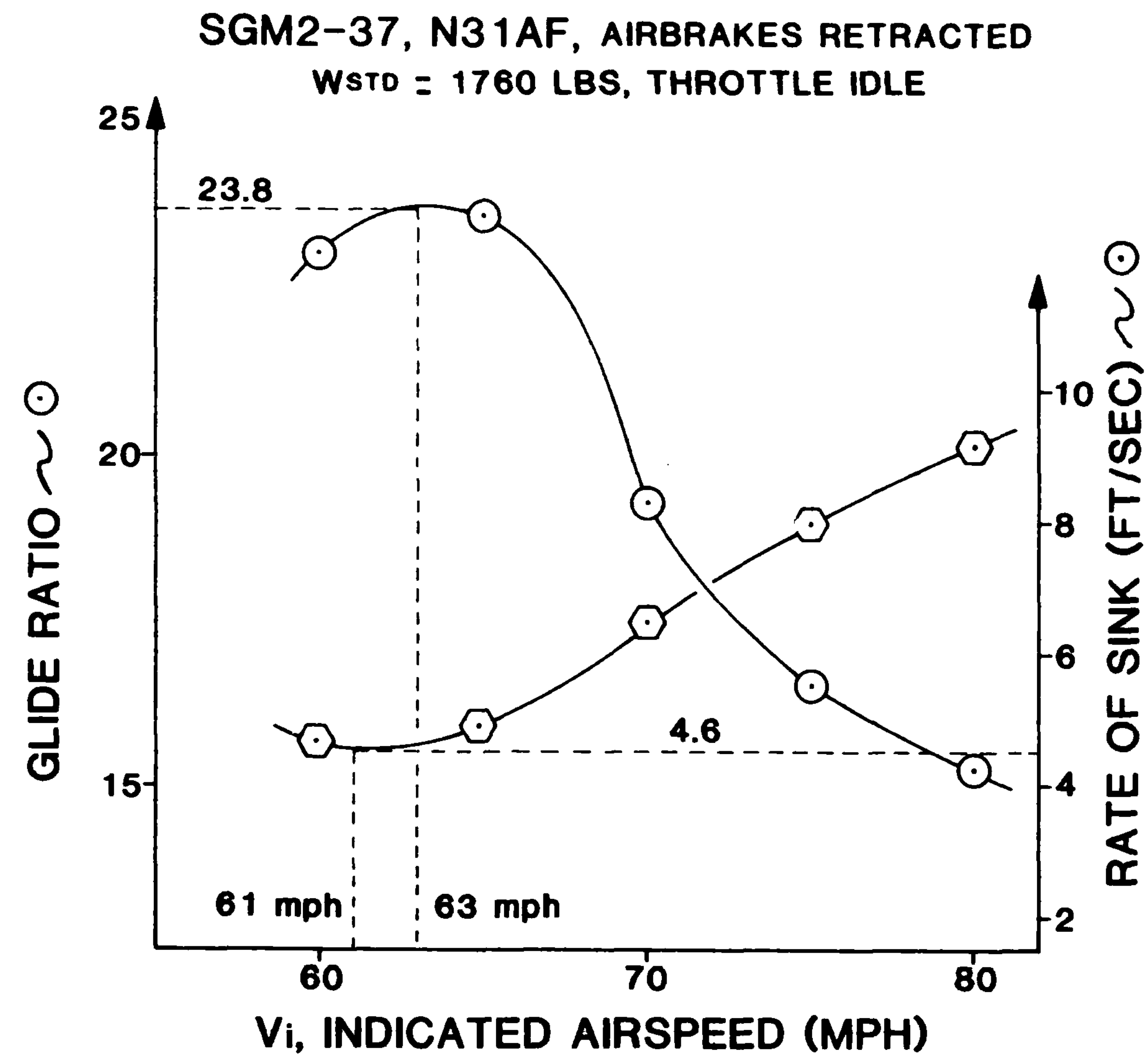


FIGURE A3. IDLE POWER, AIRBRAKES RETRACTED PERFORMANCE POLAR

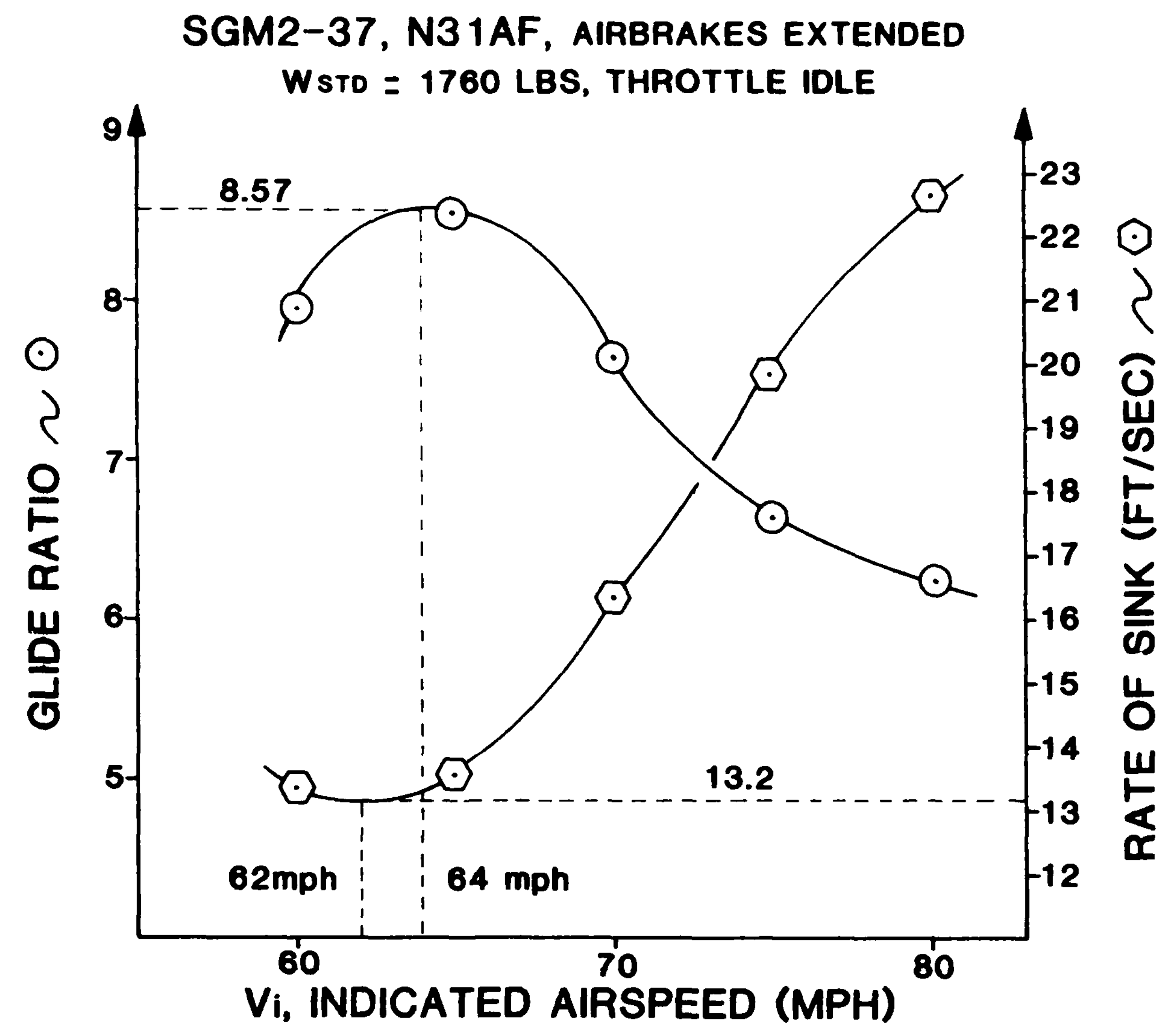


FIGURE A4. IDLE POWER, AIRBRAKES EXTENDED PERFORMANCE POLAR

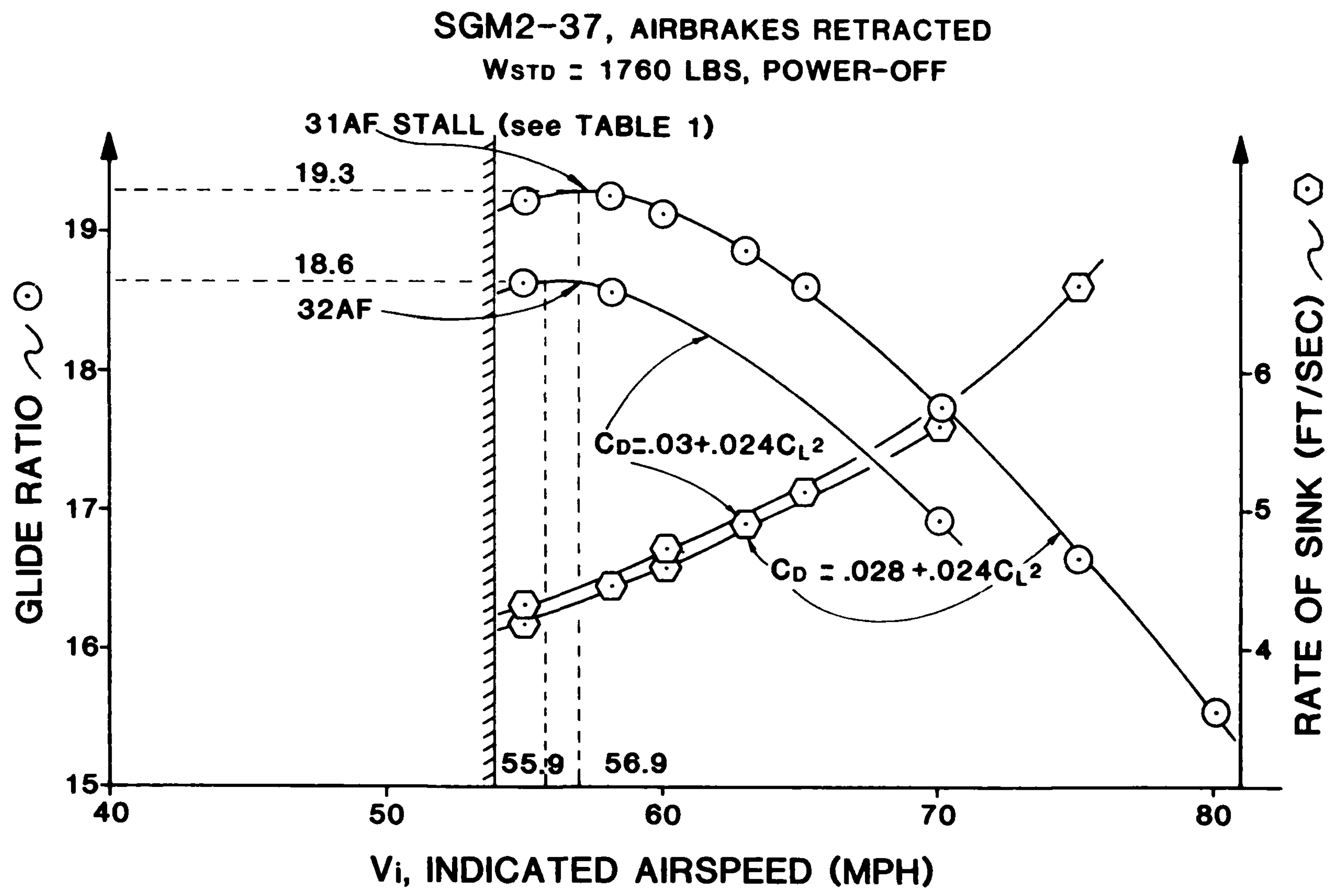


FIGURE A5. POWER-OFF, AIRBRAKES RETRACTED PERFORMANCE POLAR

SGM2-37, N31AF, AIRBRAKES RETRACTED
ALTITUDE-9000 FT (PA), TRIM AIRSPEED-70 MPH

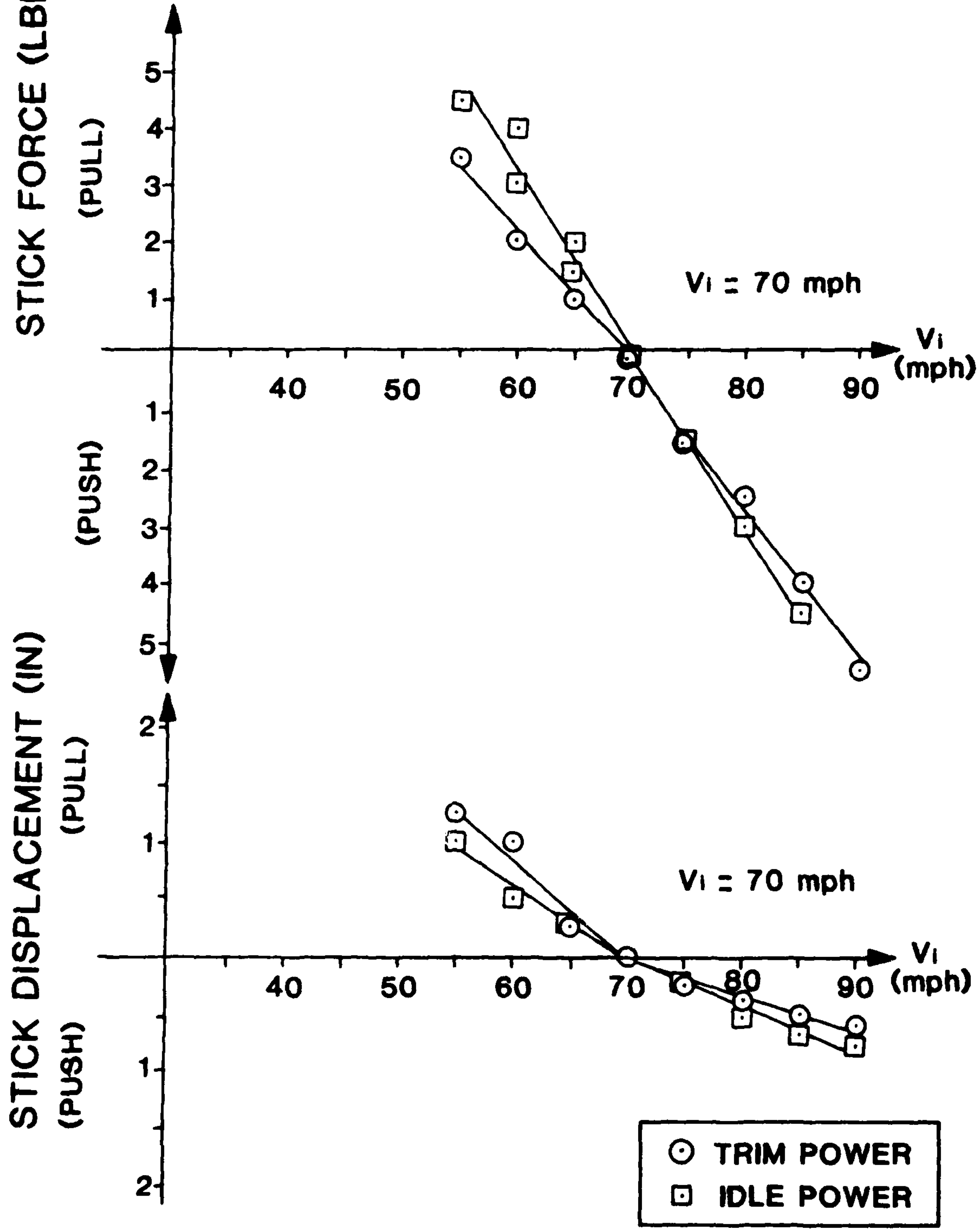


FIGURE A6. LONGITUDINAL STICK FORCE AND DISPLACEMENT VS. AIRSPEED

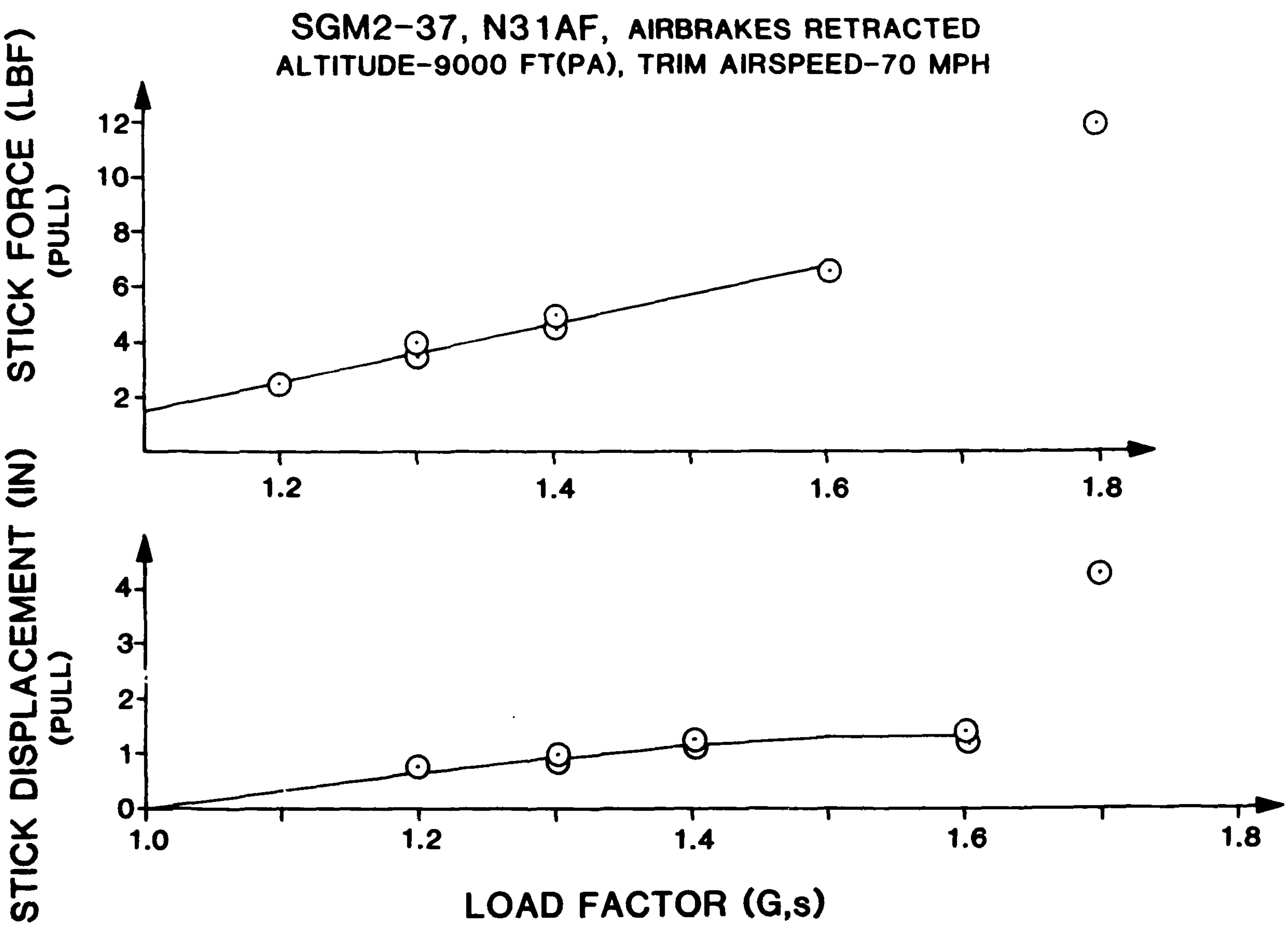


FIGURE A7. LONGITUDINAL STICK FORCE AND DISPLACEMENT VS. LOADFACTOR

SGM2-37, N31AF, AIRBRAKES RETRACTED

W_{TEST} = 1720 LBS, ALT = 9000 FT

POWER FOR LEVEL FLIGHT

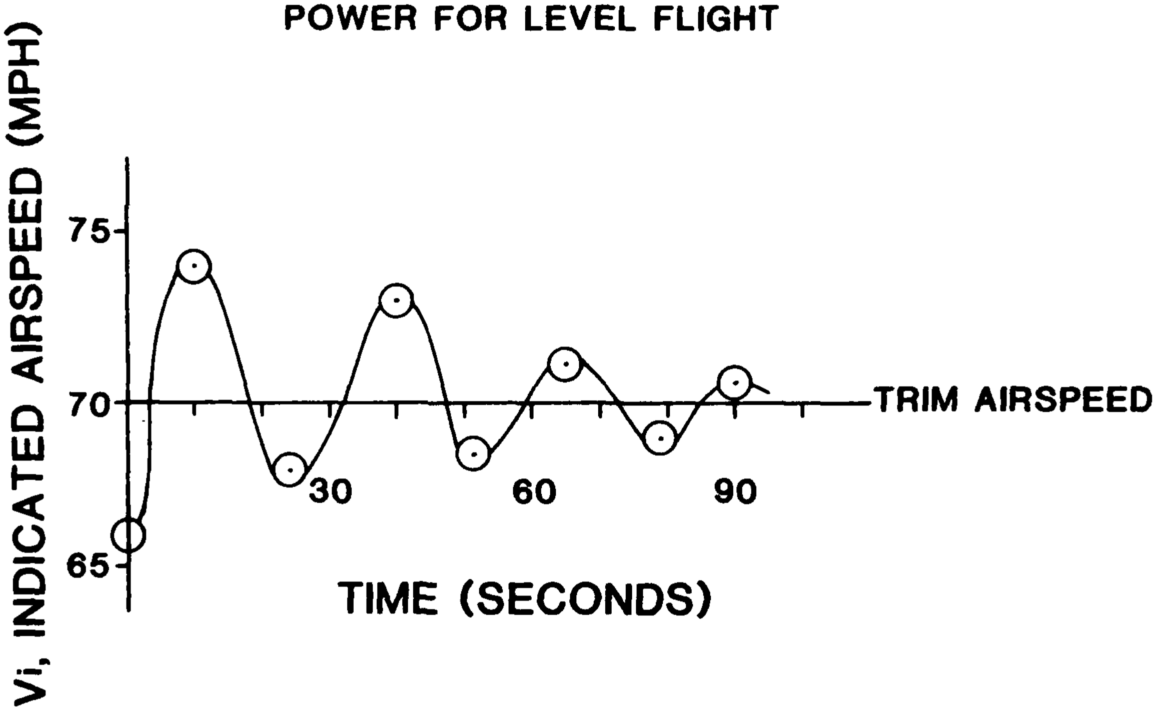


FIGURE A8. PHUGOID DYNAMIC RESPONSE

APPENDIX B

General Aircraft Information

Weight and Balance

GENERAL AIRCRAFT INFORMATION

Schweizer Aircraft Corporation
SGM 2-37

I. GENERAL DATA

A.	Wing Span	59.5 ft
B.	Wing Area	195.71 ft^2
C.	Aspect Ratio	18.09
D.	Airfoil Section Root	Wortmann FX61-163
E.	Airfoil Section Tip	Wortmann FX60-126
F.	Dihedral	3.5°
G.	Twist	1° Washout
H.	Dive Brake Area	8.79 ft^2
I.	Horizontal Tail Surface Area	21.88 ft^2
J.	Vertical Tail Surface Area	14.58 ft^2
K.	Aileron Area	10.90 ft^2

II. ENGINE

A.	Number of Engines	1
B.	Engine Manufacturer	Lycoming
C.	Engine Model Number	0-235-L2C (with Slick Mags.)
D.	Rated Horsepower	112
E.	Rated Speed (rpm)	2,600
F.	Bore (in.)	4.375
G.	Stroke (in.)	3.875
H.	Displacement (cu. in.)	233.3
I.	Compression Ratio	8.5:1
J.	Engine Type	Four Cylinder, Direct Drive, Horizontally Opposed, Air Cooled

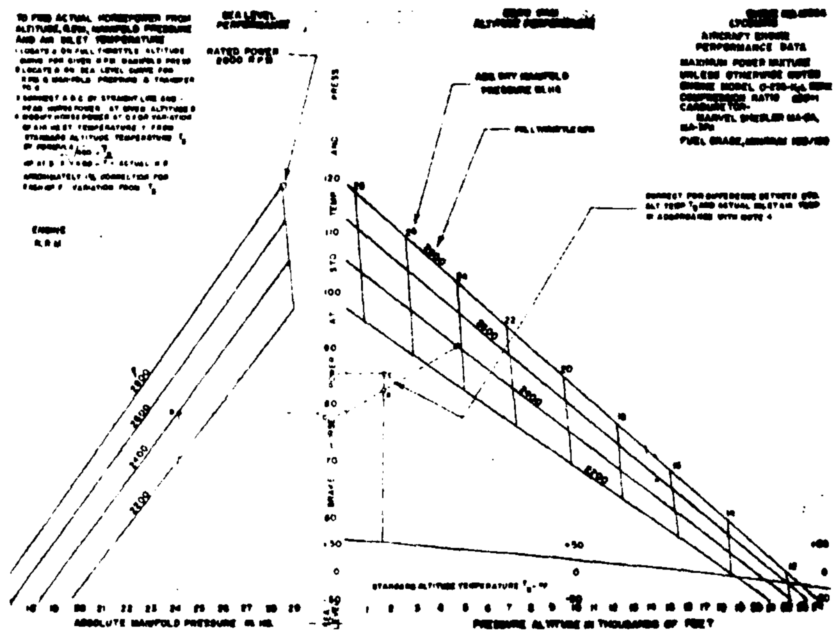


Figure B1. Sea Level and Altitude Performance - 0-235-K, -L Series

III. Propeller

A.	Number of Propellers	1
B.	Propeller Manufacturer	Sensenich
C.	Model	72CK-0-50
D.	Number of Blades	2
E.	Propeller Diameter (in)	
	(1) Maximum	72
	(2) Minimum	70
F.	Propeller Type	Fixed Pitch

IV. FUEL

A.	Fuel Capacity (U.S. gal.) (Total)	15.6
B.	Useable Fuel (U.S. gal.) (Total)	14.2
C.	Fuel Grade, Aviation	
	(1) Minimum Octane	100/130 - Green
	(2) Specified Octane	100/130 - Green 100 - Green 100LL - Blue
	(3) Alternate Fuel*	115/145 - Purple

*Alternate Fuels refers to military grade with 4.6 ml of TEL.

V. OIL

A.	Oil Capacity (U.S. qts.)	6
B.	Oil Specification	Refer to latest issue of Lycoming Service Instruction 1014.
C.	Oil Viscosity	Refer to Section 8 - paragraph 8.10.

VI. MAXIMUM WEIGHTS

		Utility
A.	Maximum Takeoff Weight (lbs)	1760
B.	Maximum Landing Weight (lbs)	1760

VII. STANDARD MOTORGLIDER WEIGHTS*

A. Standard Empty Weight (lbs): 1280

Weight of a standard motorglider including unuseable fuel, full operating fluids and full oil.

B. Maximum Useful Load (lbs): 480

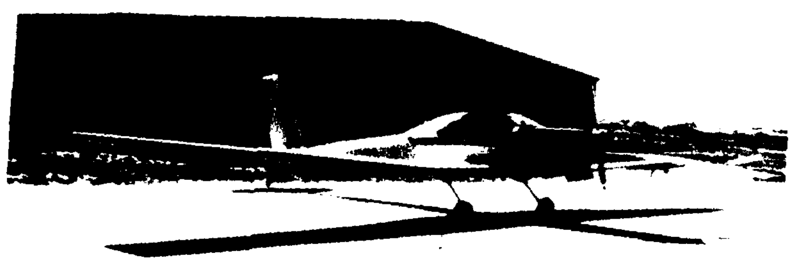
The difference between the Maximum Takeoff Weight and the Standard Empty Weight.

*These values are approximate and vary from one aircraft to another.

VIII. SPECIFIC LOADINGS

A. Wing Loading (lbs per sq. ft.) 8.99

B. Power Loading (lbs per hp) 15.71



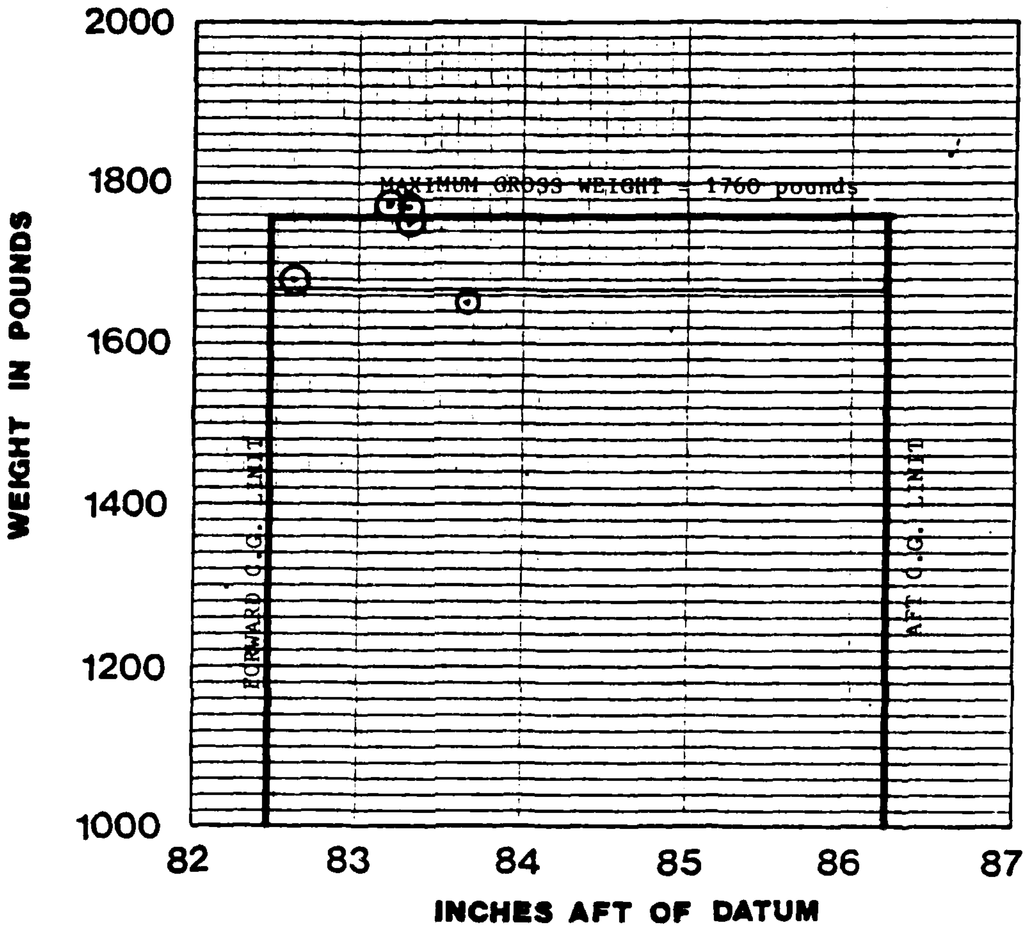
WEIGHT AND BALANCE

As shown in Figure B2, the aircraft was flown over a narrow center of gravity and weight range of 82.56 to 83.66 inches aft of the datum and 1648 to 1779 pounds respectively. Figures shown in Table B1 for aircraft registration number N31AF are based on the weight and balance figures derived from weighing the aircraft at the Academy on 3 May 1983. Figures shown in the same table for N32AF are based on the manufacturer's results found in the Operating Handbook (3:6-5). Moments and moment arms for all crew weights and fuel loadings shown in Table B1 were found by using the charts found in the Operating Handbook (3:6-9 and 6-10).

As discussed under the operational handling section of this report, the aircraft should be certified for a higher gross weight. With the current maximum gross weight limit of only 1760 pounds, N31AF exceeded this weight by 1% with a full fuel load and two crewmembers on board. While this over weight condition was not considered significant enough to warrant downloading fuel prior to takeoff, there is absolutely no flexibility within the current weight limit for higher crew weights and for adding equipment to the aircraft.

Referring to Tables B2 and B3, the SGM 2-37 aft center of gravity is very insensitive to different fuel loadings and combinations of crew weight. The lighter the fuel and crew load, the further aft the center of gravity moves. With a solo 110 pound pilot and only 4.5 gallons of fuel on board, the center of gravity is only as far aft as 83.2 inches from the datum. The aft allowable limit shown in Figure B2 is 86.2 inches. For this reason, the aircraft was not evaluated at its aft center of gravity limit during the validation program. With the current configuration of the aircraft, it does not appear possible under normal operations to even approach the aft center of gravity limit.

The forward center of gravity limit, however, can be exceeded with a full fuel load and a combined crew weight from 350 to 360 pounds. The center of gravity location moves as far forward as 82.4 inches from the datum under these conditions.



⊙ – Aircraft flown at these centers of gravity and weights during the Validation Program.

Figure B2. Weight and Center of Gravity Ranges Evaluated

Table B1. **WEIGHT AND BALANCE** CALCULATIONS

AIRCRAFT SERIAL NO. 1
AIRCRAFT REG. NO. N31AF
DATE: 27 April 83

Space is provided below for you to perform your own loading problem.

ITEMS	WEIGHT (LBS)	ARM (INCHES)	MOMENT (IN. LBS)
BASIC AIRCRAFT EMPTY WEIGHT	1318.55	85.28	112440.3
BAGGAGE	—	—	—
(14.2) GAL. OF FUEL @ 6#/ GAL.	85.2	80.4	6850.0
1.5 GAL. OF OIL @ 7.5#/ GAL.	11.25	19.6	220.5
PILOT	182.0	78.4	14268.8
PASSENGER	182.0	78.4	14268.8
WEIGHT AND BALANCE	1779.0	83.22	148048.4

AIRCRAFT SERIAL NO. 1
AIRCRAFT REG. NO. N31AF
DATE: 3 May 83

Space is provided below for you to perform your own loading problem.

ITEMS	WEIGHT (LBS)	ARM (INCHES)	MOMENT (IN. LBS)
BASIC AIRCRAFT EMPTY WEIGHT	1318.55	85.28	112440.3
BAGGAGE	—	—	—
(14.2) GAL. OF FUEL @ 6#/ GAL.	85.2	80.4	6850.0
1.5 GAL. OF OIL @ 7.5#/ GAL.	11.25	19.6	220.5
PILOT	182.0	78.4	14268.8
PASSENGER	182.0	78.4	14268.8
WEIGHT AND BALANCE	1779.0	83.22	148048.4

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Table B1. **WEIGHT AND BALANCE** CALCULATIONS (cont'd)

AIRCRAFT SERIAL NO. 1
AIRCRAFT REG. NO. N31AF
DATE: 5 May 83

Space is provided below for you to perform your own loading problem.

ITEMS	WEIGHT (LBS)	ARM (INCHES)	MOMENT (IN. LBS)
BASIC AIRCRAFT EMPTY WEIGHT	1318.55	85.28	112440.3
BAGGAGE	—	—	—
(9.2) GAL. OF FUEL @ 6#/ GAL.	55.2	81.52	4500.0
1.5 GAL. OF OIL @ 7.5#/ GAL.	11.25	19.6	220.5
PILOT	193.0	78.6	15169.8
PASSENGER	193.0	78.6	15169.8
WEIGHT AND BALANCE	1771.0	83.29	147500.4

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AIRCRAFT SERIAL NO. 1
AIRCRAFT REG. NO. N31AF
DATE: 9 May 83

Space is provided below for you to perform your own loading problem.

ITEMS	WEIGHT (LBS)	ARM (INCHES)	MOMENT (IN. LBS)
BASIC AIRCRAFT EMPTY WEIGHT	1318.55	85.28	112440.3
BAGGAGE	—	—	—
(10.6) GAL. OF FUEL @ 6#/ GAL.	63.6	81.76	5200.0
1.5 GAL. OF OIL @ 7.5#/ GAL.	11.25	19.6	220.5
PILOT	182.0	78.4	14268.8
PASSENGER	182.0	78.4	14268.8
WEIGHT AND BALANCE	1757.4	83.30	146,398.4

Table b1. **WEIGHT AND BALANCE** CALCULATIONS (cont'd)

AIRCRAFT SERIAL NO. 1
AIRCRAFT REG. NO. N31AF
DATE: 9 May 83

Space is provided below for you to perform your own loading problem.

ITEMS	WEIGHT (LBS)	ARM (INCHES)	MOMENT (IN. LBS)
BASIC AIRCRAFT EMPTY WEIGHT	1318.55	85.28	112440.3
BAGGAGE	—	—	—
(10.6) GAL. OF FUEL @ 6#/ GAL.	63.6	81.76	5200.0
1.5 GAL. OF OIL @ 7.5#/ GAL.	11.25	19.6	220.5
PILOT	182.0	78.4	14268.8
PASSENGER	182.0	78.4	14268.8
WEIGHT AND BALANCE	1757.4	83.30	146398.4

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AIRCRAFT SERIAL NO. 1
AIRCRAFT REG. NO. N31AF
DATE: 11 May 83

Space is provided below for you to perform your own loading problem.

ITEMS	WEIGHT (LBS)	ARM (INCHES)	MOMENT (IN. LBS)
BASIC AIRCRAFT EMPTY WEIGHT	1318.55	85.28	112440.3
BAGGAGE	—	—	—
(12.6) GAL. OF FUEL @ 6#/ GAL.	75.6	80.69	6100.0
1.5 GAL. OF OIL @ 7.5#/ GAL.	11.25	19.6	220.5
PILOT	182.0	78.4	14268.8
PASSENGER	182.0	78.4	14268.8
WEIGHT AND BALANCE	1769.4	83.25	147298.4

Table B1. **WEIGHT AND BALANCE** CALCULATIONS (cont'd)

AIRCRAFT SERIAL NO. 1
AIRCRAFT REG. NO. N31AF
DATE: 12 May 83

Space is provided below for you to perform your own loading problem.

ITEMS	WEIGHT (LBS)	ARM (INCHES)	MOMENT (IN. LBS)
BASIC AIRCRAFT EMPTY WEIGHT	1318.55	85.28	112440.3
BAGGAGE	—	—	—
(10.6 GAL. OF FUEL @ 6#/ GAL.	63.6	81.76	5200.0
1.5 GAL. OF OIL @ 7.5#/ GAL.	11.25	19.6	220.5
PILOT	175.0	78.3	13702.5
PASSENGER	182.0	78.4	14268.8
WEIGHT AND BALANCE	1750.4	83.31	145832.1

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AIRCRAFT SERIAL NO. 1
AIRCRAFT REG. NO. N31AF
DATE: 19 May 83

Space is provided below for you to perform your own loading problem.

ITEMS	WEIGHT (LBS)	ARM (INCHES)	MOMENT (IN. LBS)
BASIC AIRCRAFT EMPTY WEIGHT	1318.55	85.28	112440.3
BAGGAGE	—	—	—
(13.6 GAL. OF FUEL @ 6#/ GAL.	81.6	80.88	6600.0
1.5 GAL. OF OIL @ 7.5#/ GAL.	11.25	19.6	220.5
PILOT	182.0	78.4	14268.8
PASSENGER	182.0	78.4	14268.8
WEIGHT AND BALANCE	1775.4	83.25	147798.4

Table B1. **WEIGHT AND BALANCE** CALCULATIONS (cont'd)

AIRCRAFT SERIAL NO. 1
AIRCRAFT REG. NO. N31AF
DATE: 23 May 83

Space is provided below for you to perform your own loading problem.

ITEMS	WEIGHT (LBS)	ARM (INCHES)	MOMENT (IN. LBS)
BASIC AIRCRAFT EMPTY WEIGHT	1318.55	85.28	112440.3
BAGGAGE	—	—	—
(14.2) GAL. OF FUEL @ 6#/ GAL.	85.2	80.4	6850.0
1.5 GAL. OF OIL @ 7.5#/ GAL.	11.25	19.6	220.5
PILOT	233.0	78.8	18360.4
PASSENGER	—	—	—
WEIGHT AND BALANCE	1648.0	83.66	137871.2

AIRCRAFT SERIAL NO. 2
AIRCRAFT REG. NO. N32AF
DATE: 27 May 83

Space is provided below for you to perform your own loading problem.

ITEMS	WEIGHT (LBS)	ARM (INCHES)	MOMENT (IN. LBS)
BASIC AIRCRAFT EMPTY WEIGHT	1265.0	84.37	106734.0
BAGGAGE	—	—	—
(6.6) GAL. OF FUEL @ 6#/ GAL.	39.6	80.81	3200.0
1.5 GAL. OF OIL @ 7.5#/ GAL.	11.25	19.6	220.5
PILOT	182.0	78.4	14268.8
PASSENGER	182.0	78.4	14268.8
WEIGHT AND BALANCE	1679.85	82.56	138692.1

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TABLE B2. WEIGHT AND BALANCE FOR CREW WEIGHT
(14.2 GALLONS OF FUEL)

CREW WEIGHT	110	120	140	160	180	200	220	240
0	83.0	83.0	83.0	83.1	83.1	83.0	83.0	82.9
110	83.0	82.5	82.5	82.5	82.5	82.5	82.5	82.4
120	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.4
140	82.5	82.5	82.5	82.5	82.6	82.5	82.5	82.5
160	82.5	82.5	82.5	82.6	82.6	82.6	82.5	
180	82.5	82.5	82.6	82.6	82.6	82.6		
200	82.5	82.5	82.5	82.6	82.6			
220	82.5	82.5	82.5	82.5				
240	82.4	82.4	82.5					

NOTE: Crew weight is in pounds. Numbers corresponding to crew weights represent the center of gravity location aft of the DATUM STA 0.00 (see figure below.)

Forward C.G. Limit Exceeded

Maximum Gross Weight Exceeded (1,760 pounds)

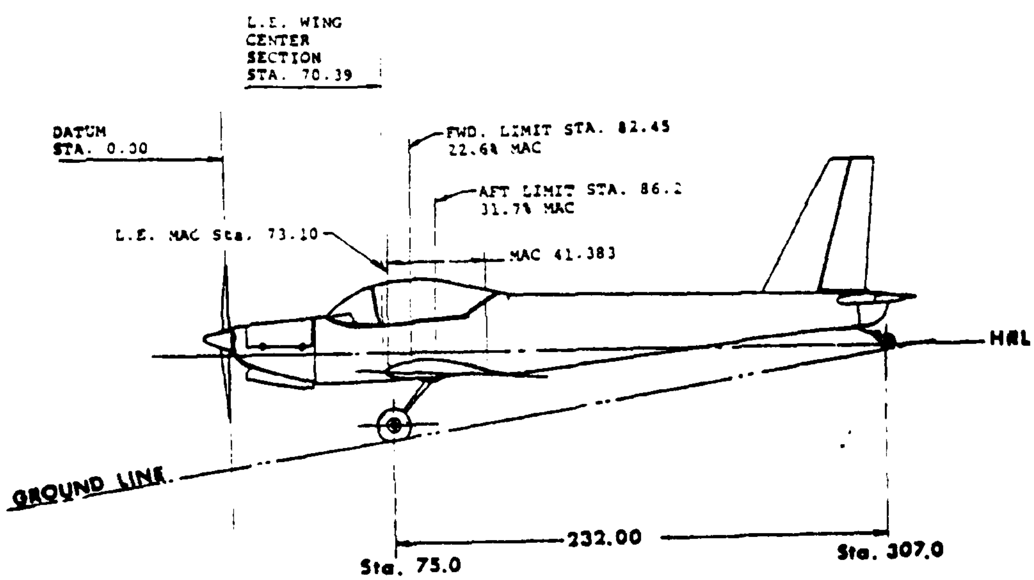


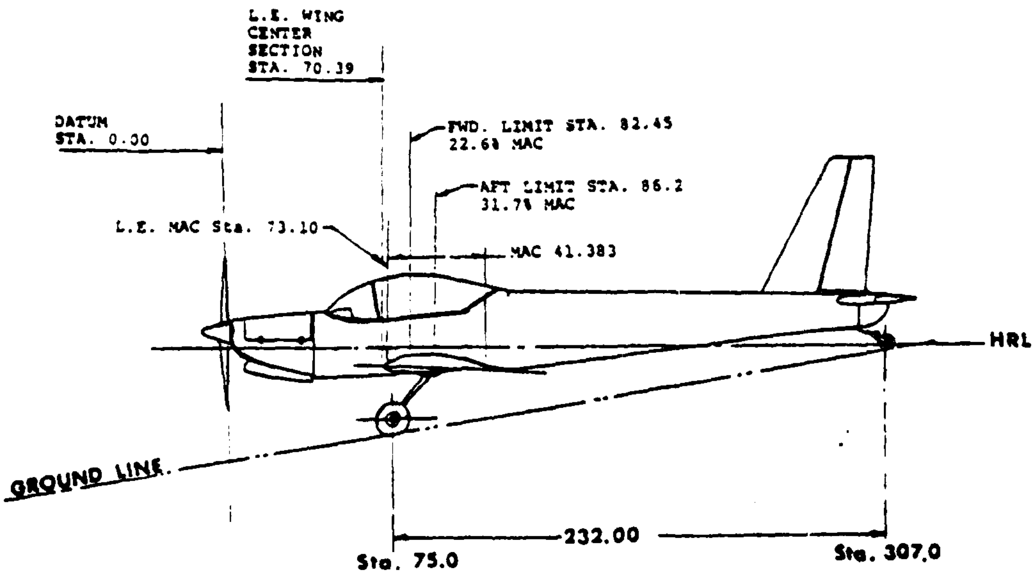
TABLE B3. WEIGHT AND BALANCE FOR CREW WEIGHT
(4.5 GALLONS OF FUEL)

CREW WEIGHT	110	120	140	160	180	200	220	240
0	83.2	83.2	83.2	83.2	83.2	83.2	83.1	83.1
110	82.6	82.6	82.6	82.6	82.6	82.6	82.6	82.5
120	82.6	82.6	82.6	82.6	82.6	82.6	82.6	82.5
140	82.6	82.6	82.6	82.6	82.7	82.6	82.6	82.6
160	82.6	82.6	82.6	82.7	82.7	82.6	82.6	82.6
180	82.6	82.6	82.7	82.7	82.7	82.7	82.6	82.6
200	82.6	82.6	82.6	82.6	82.7	82.6	82.6	82.6
220	82.6	82.6	82.6	82.6	82.6	82.6	82.6	
240	82.5	82.5	82.6	82.6	82.6	82.6		

NOTE: Crew weight is in pounds. Numbers corresponding to crew weights represent the center of gravity location aft of the DATUM STA 0.00. (See figure below.)

Forward C.G. Limit Exceeded

Maximum Gross Weight Exceeded (1,760 pounds)



APPENDIX C

Data and Data Reduction Methods

CONTENTS

PAGE

DATA AND DATA REDUCTION METHODS

I. Introduction

The following is a detailed discussion of the flight test techniques, in-flight data requirements and data reduction procedures used during the SGM 2-37 validation program. The only quantitative data that was gathered, reduced, and either plotted or tabulated was obtained from pitot-static calibration runs, takeoffs, climbs, glides, stalls, and from looking at some of the dynamic characteristics of the aircraft. Data and data reduction methods for each of these areas are discussed below.

II. Pitot-Static Calibration

A. Background

The pitot-static system was calibrated by flying east and west on a 1.7 statute mile ground course north of the Academy. The course was flown at 7,500 feet pressure altitude at airspeeds between 55 and 110 mph in both air-brake configurations--extended and retracted.

In order to eliminate wind drift effects, each run was performed at a given airspeed in both directions and the results averaged.

B. Data Requirements and Data Reduction

In-Flight Data Recorded

(1) Indicated Airspeed, V_i (mph)

(2) Indicated Pressure Altitude, H_i (ft)

(3) Outside Air Temperature, OAT (°F)

(4) Ground Course Flight Time (sec)

Post-Flight Data Reduction

(5) OAT (°R) = (3) + 460

(6) True Airspeed, V_T (mph)

$$V_T = \frac{(1.7)\ (3600)}{④}$$

(7) Average True Airspeed (mph)

$$V_{T_{AVG}} = \frac{⑥_W + ⑥_E}{2} \qquad \begin{pmatrix} W - \text{West} \\ E - \text{East} \end{pmatrix}$$

(8) Average Pressure Altitude (ft)

$$H_{i_{AVG}} = \frac{②_W + ②_E}{2}$$

(9) Pressure, p (inches of Mercury, Hg)

$$p = (29.92)[1 - 6.875^{-6} \times (8)\ ]^{5.2561}$$

(10) Density, ρ (slugs/ft^3)

$$\rho = \frac{(9)}{(5) \times (24.236)}$$

(11) Density Ratio, σ

$$\sigma = \frac{(10)}{.00238}$$

(12) Equivalent Airspeed, V_e (mph)

$$V_e = \sqrt{(11)} \times (7)$$

(13) Average Indicated Airspeed (mph)

$$V_{i_{AVG}} = \frac{(1)_W + (1)_E}{2}$$

* (14) Airspeed Position Error, ΔV_{pc} (mph)

$$\Delta V_{pc} = (12) - (13)$$

(assumes equivalent and calibrated airspeeds are equal)

* (15) Altimeter Position Error, ΔH_{pc} (ft)

$$\Delta H_{pc} = \frac{(\frac{1}{2}\ \rho_{SL}) \times [\ (12)^2 - (13)^2]}{(10) \times g}$$

*These parameters are then plotted or tabulated versus calibrated airspeed.

NOTE: Data reduction scheme shown above neglects instrument error and angle of attack effects.

III. Takeoffs

A. Background

Takeoff ground run data were obtained by using the runway complex at Peterson AFB. Takeoff ground run measurement commenced with brake release starting with the throttle at 800 rpm followed by a five second throttle movement to full power. Ground run was determined by counting runway lights which are positioned along both sides of the runway in 200 foot intervals. All data were standardized to a maximum gross weight of 1,760 pounds and 10,000 feet density altitude.

B. Data Requirements and Data Reduction

Ground Run Data Recorded

(1) Measured Ground Run to Lift-Off, S_{G_i} (ft)

(2) Wind Velocity Down the Runway, V_w (ft/sec)

(3) Outside Air Temperature, OAT (°R)

(4) Lift-Off Airspeed, V_{TO} (ft/sec)

(5) Fuel on Board, W_f (lbs)

(6) Indicated Pressure Altitude, H_i (ft)

Post-Flight Data Reduction

(7) Pressure Ratio, δ

$$\delta = (1 - 6.8765 \times 10^{-6} \times (6))^{5.2561}$$

(8) Density Ratio, σ

$$\sigma = \delta / \left(\frac{(3)}{519}\right)$$

(9) Ground Run Corrected for Wind, S_{G_W} (ft)

$$S_{G_W} = S_{G_i}\left(1 + \frac{(2)}{(4)}\right)^{1.85}$$

(10) Test Weight, W_t (lb_f)

$$W_t = \text{Basic Weight} + \text{Crew Weight} + (5)$$

(11) Ground Run Corrected for Standard Density and Standard Weight (1,760 lbs), S_G (ft)

$$S_G = (9) \times (8) \left(\frac{1{,}760}{(10)}\right)^{2.7}$$

* (12) Ground Run Corrected to 10,000 ft Density Altitude, $S_{G_{STD}}$ (ft)

$$S_{G_{STD}} = (11) \left(\frac{\sigma_{10{,}000}}{(8)}\right)$$

*This parameter is tabulated with calibrated takeoff airspeeds.

NOTE: Runway slope effects are negligible.

IV. Climbs

A. Background

Sawtooth climbs were flown at selected airspeeds from 500 feet below to 500 feet above the test pressure altitudes evaluated. Climbs at each airspeed were performed on reciprocal headings in order to eliminate wind gradient effects. The mixture lever was leaned to the screw stop and the electric fuel pump was left on during all climbs. Data were standardized to a maximum gross weight of 1,760 pounds and to standard atmospheric conditions.

B. Data Requirements and Data Reduction

In-Flight Data Recorded

(1) Indicated Airspeed, V_i (mph)

(2) Indicated Pressure Altitude, H_i (ft)

(3) Fuel on Board, W_f (lbs)

(4) Outside Air Temperature, OAT (°F)

(5) Manifold Pressure, MAP (in of Hg)

(6) Engine RPM

(7) Time to Climb (sec's)

Post-Flight Data Reduction

(8) Test Weight, W_t (lbs)

W_t = Basic Weight + Crew + (3)

*(9) Airspeed Corrected for Standard Weight (1,760), V_{iw} (mph)

$$V_{iw} = (1) \left(\frac{1,760}{(8)}\right)^{\frac{1}{2}}$$

(10) Plot (2) versus (7), draw tangent to plot at test altitude and determine test rate of climb, $R/C)_t$ (ft/sec)

(11) Temperature Ratio, $\frac{T_t}{T_s}$

$$\frac{T_t}{T_s} = \frac{(4) + 460}{\text{standard temp at test altitude}}$$

(12) Density Correction to Rate of Climb, $R/C)_d$ (ft/sec)

$$R/D)_d = (10)\sqrt{(11)}$$

13 Find Test Brake Horsepower (BHP_t) from Figure B1 using 4, 5, 6 and 2

14 Find Standard Brake Horsepower (BHP_s) from Figure B1 using 5, 6 and 2

15 Calculate ΔBHP = 14 - 13

16 Engine Power and Propulsive Efficiency Correction to Rate of Climb, $\Delta R/C$ (ft/sec)

$$\Delta R/C = \frac{.8}{1,760}\left[⑮ + ⑭\left(1 - \frac{1}{⑪}\right)\right]550$$

17 Calculate $R/C)_p$ = 12 + 16 (ft/sec)

* 18 Weight Correction to Rate of Climb, $R/C)_{STD}$ (ft/sec)

$$R/C)_{STD} = ⑰\sqrt{\frac{1,760}{⑧}}$$

*These parameters are plotted against each other.

NOTE: Data reduction assumes a nominal propeller efficiency of .8.

V. Glides

A. Background

Sawtooth glides with the throttle at idle were flown at selected airspeeds from 500 feet above to 500 feet below the test pressure altitude and were performed while alternating with sawtooth climbs, just discussed. Power-off glides, however, were flown over several altitudes, and the data are more susceptible to wind gradient effects. For throttle idle glides, the mixture was leaned to the screw stop and the electric fuel pump was left on. During all power-off glides, the prop was stopped in the horizontal position. All data were standardized to a maximum gross weight of 1,760 pounds and to standard atmospheric conditions.

B. Data Requirements and Data Reduction

In-Flight Data Recorded

1 Indicated Airspeed, V_i (mph)

2 Indicated Pressure Altitude, H_i (ft)

3 Fuel on Board, W_f (lbs)

4 Outside Air Temperature, OAT (°F)

5 Time to Descent (sec's)

(6) Test Weight, W_t (lbs)

$$W_t = \text{Basic Weight} + \text{Crew} + (3)$$

*(7) Airspeed Corrected for Standard Weight (1,760 pounds), V_{iw} (mph)

$$V_{iw} = (1)\left(\frac{1,760}{(6)}\right)^{1/2}$$

(8) Plot (2) versus (5), draw tangent to plot at test altitude, and determine test rate of descent, $R/D)_t$ (ft/sec)

(9) Temperature Ratio, $\frac{T_t}{T_s}$

$$\frac{T_t}{T_s} = \frac{(4) + 460}{\text{Standard Temp at Test Altitude}}$$

(10) Density Correction to Rate of Descent, $R/D)_d$ (ft/sec)

$$R/D)_d = (8)\sqrt{(9)}$$

*(11) Weight Correction to Rate of Descent, $R/D)_{STD}$ (ft/sec)

$$R/D)_{STD} = (10)\sqrt{\frac{1,760}{(6)}}$$

(12) Calculate pressure ratio, δ

$$\delta = (1 - 6.875 \times 10^{-6} \times (2))^{5.2561}$$

(13) Calculate density ratio, σ

$$\sigma = \frac{(12)}{\left(\frac{(4) + 460}{519}\right)}$$

(14) True Airspeed, V_T (mph)

$$V_T = \frac{(1)}{\sqrt{(13)}}$$

(15) Calculate Lift Coefficient, C_L

$$C_L = \frac{(6)}{\tfrac{1}{2}(.002378)((1) \times 1.467)^2\ 196}$$

(16) Calculate Drag Coefficient, C_D

$$C_D = \frac{(10) \times (6)/((14) \times 1.467)}{\tfrac{1}{2}(.002378)((1) \times 1.467)^2\ 196}$$

*(17) Calculate Glide Ratio, C_L/C_D

*Plot (7) versus (11) and (17)

NOTE: Calculation for C_L assumes a small descent rate.

VI. Stalls

A. Background

The test technique used for all stall evaluations is discussed in detail in the body of the report. Data reduction only involves standardizing the stall speeds to a standard gross weight of 1,760 pounds.

B. Data Requirements and Data Reduction

In-Flight Data Recorded

(1) Indicated Pressure Altitude, H_i (ft)

(2) Indicated Stall Airspeed, V_{i_s} (mph)

(3) Fuel on Board, W_f (lbs)

Post-Flight Data Reduction

(4) Test Weight, W_t (lbs)

W_t = Basic Weight + Crew + (3)

*(5) Stall Airspeed Corrected for Standard Weight, V_s (mph)

$$V_s = (2)\sqrt{\frac{1{,}760}{(4)}}$$

*This parameter is tabulated as a function of stall entry, throttle position and airbrake configuration.

VII. Dynamic Characteristics

A. Background

The only data reduction performed during the evaluation of the dynamic characteristics of the SGM 2-37 involved the phugoid longitudinal dynamic mode and the Dutch roll lateral-directional dynamic mode. Data for both dynamic modes were gathered for only one flight condition and were not standardized to a particular weight or standard atmospheric conditions as were the performance data parameters discussed previously.

Both of the dynamic modes evaluated (phugoid and Dutch roll) are oscillatory. The phugoid was excited by bleeding off approximately 10 mph of airspeed and releasing the controls. As shown in Figure A8, the aircraft is dynamically stable as it returns to the trimmed flight condition. The Dutch roll was excited using two techniques--pulsing the rudder pedals by ½ deflection either side of neutral and by releasing the controls out of a steady straight sideslip condition.

Data reduction for both modes involved calculating damping ratios, frequencies and times to half amplitude.

B. Dutch Roll

The aircraft exhibits approximately twice as much yaw as roll as it oscillates back toward trimmed flight. The motion damped out after four overshoots in eight seconds for both types of entries discussed above. All data were obtained visually by watching the aircraft motion relative to the horizon. Damping ratio, frequency, and times to half amplitude were calculated as follows:

<u>In-Flight Data Recorded</u>

(1) Number of overshoots, # OS = 4

(2) Total number of oscillations, t (sec's) = 8 sec's

<u>Post-Flight Data Reduction</u>

(3) Damping Ratio, ζ

$$\zeta = \frac{7 - (1)}{10} = .3$$

(4) Period of Oscillation, T (sec's)

$$T = \frac{(2)}{1.75} = 4.57 \text{ sec's}$$

(5) Actual Frequency, ω_d (radians/sec)

$$\omega_d = \frac{2\pi}{(4)} = 1.374 \text{ rad/sec}$$

(6) Natural Frequency, ω_n (radians/sec)

$$\omega_n = \frac{(5)}{\sqrt{1 - (3)^2}} = 1.44 \text{ rad/sec}$$

(7) Time to Half Amplitude, $t_{1/2}$ (sec's)

$$t_{1/2} = \frac{.69}{(3) \times (6)} = 1.59 \text{ sec's}$$

NOTE: Actual results are indicated with each step of the data reduction process shown above.

C. Phugoid

This data was recorded each time the vertical velocity indicator (VVI) passed through zero.

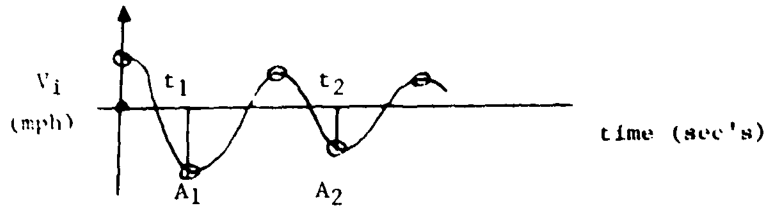
<u>In-Flight Data Recorded</u>

(1) Indicated Airspeed, V_i (mph)

(2) Indicated Altitude, H_i (ft)

(3) Time Between Zero VVI readings, Δt (sec's)

Post-Flight Data Reduction



Raw data plotted as shown in Figure A8 as V_i versus time.

(4) $A_1 = e^{-\zeta\omega_n t_1}$

$A_2 = e^{-\zeta\omega_n t_2}$

$\frac{A_1}{A_2} = e^{\zeta\omega_n (t_2 - t_1)}$

$\therefore \zeta\omega_n = \frac{\ln\left(\frac{A_1}{A_2}\right)}{t_2 - t_1}$

(5) $\omega_d = \frac{2\pi}{T = 26 \text{ sec's}}$ (radians/sec) = .243 rad/sec

(6) $\omega_n = [(5)^2 + (4)^2]^{1/2}$ = .244 rad/sec

(7) $\zeta = \frac{(4)}{(6)}$ = .094

(8) $t_{1/2} = .69/(4)$ = 30 sec's

NOTE: This process was performed for peaks 1 and 3, 1 and 5, 1 and 7, 3 and 5, 3 and 7, 2 and 4, 2 and 6, and 4 and 6. The results were then averaged to yield the values shown above.

APPENDIX D

Initial Flight Test Reports

INITIAL FLIGHT TEST REPORT	1. AIRCRAFT TYPE SGM 2-37	2. SERIAL NUMBER N31AF

3. CONDITIONS RELATIVE TO TEST

a. DATE 27 April 1983	e. CONFIGURATION Power Cruise and Approach	i. FUEL LOAD 15.6 gallons
b. PILOT K. R. Crenshaw	f. INSTRUMENTATION Stopwatch	j. SURFACE WIND Calm
c. OBSERVER D. G. Picha	g. START UP GR WT 1779 lbs	k. WEATHER Clear
d. SORTIE TIME/TO TIME 2.4 / 0700 Local	h. START UP C G 24.5% MAC	l. GROUND BLOCK

4. TESTS PERFORMED

1. Trim Changes using airbrakes and large throttle changes.
2. Dynamic characteristics investigating rolls with ½ and full aileron deflection, Dutch roll and short period.
3. Pitot-static calibration runs.

Note: Items 1 and 2 were recorded on videotape from a UH1 helicopter.

5. RESULTS OF TESTS *(Continue on reverse side if needed)*

1. No noticeable trim change was required from a cruise configuration at 65 mph when the airbrakes were deployed to full extension. Also, no trim change was required when the throttle was brought rapidly to idle.
2. Roll response at 65 mph was sluggish and required leading aileron with rudder to avoid adverse yaw effects. Dutch roll was very stable and resulted in less than four overshoots. The short period was deadbeat. These dynamic maneuvers were only qualitatively

6. REMARKS *(Continue on reverse side if needed)*

evaluated for the purpose of obtaining photographic coverage. More quantitative data will be taken later.

3. Pitot-static calibration runs were performed over a 1.7 statute mile ground course North of the Academy Airfield. These were done at the following airspeeds and for the configurations indicated.

V_i (mph)	Configuration: Airbrakes Retracted	Configuration: Airbrakes Extended
55	X	X
60	X	X
70	X	X
80	X	
90	X	
100	X	
110	X	

No noticeable errors were introduced into the pitot-static system by flying with the airbrakes extended. These tests were flown in light turbulence and may have to be repeated on later flights.

MISCELLANEOUS OBSERVATIONS

Cockpit - 1. Pilot's microphone mount on right side difficult to handle. This is particularly a problem in the traffic pattern.

2. Airbrake handle on left side has a tendency to contact the student pilot's leg during retraction and extension. It cannot be locked from the left side.

Continued on next page.

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3. Full aileron throw also difficult due to contact with pilot's left or right leg. This is true in both seats.

Pre-flight -

1. Tendency to grab the canopy when entering or exiting the aircraft should be avoided due to possible warping of the canopy frame and subsequent binding in the track. Closing and opening the canopy should be accomplished by applying force at the center or evenly on both sides.
2. Fuel testers with screwdriver should be obtained for each powered sailplane in order to facilitate checking fuel tank sump and for easier opening of the fuel cap.

Taxi -

1. Sharp or rapid turning maneuvers should be avoided since the tailwheel may disengage from the steering system resulting in loss of directional control. Differential braking does not seem to be particularly effective under all conditions.
2. Airbrakes should be left deployed for pre-flight and also during taxi operations to avoid possible ground handling problems due to high winds and gusts.

Air Operations -

1. Full throttle operation with retracted airbrakes at constant altitude results in exceeding the maximum rated RPM of 2600. This has been observed at altitudes up to and including 10,000 feet MSL.
2. Effective leaning of the engine occurs by pulling the mixture lever back to the screw stop prior to takeoff.

AD-A131 445 LIMITED PERFORMANCE AND FLYING QUALITIES VALIDATION OF THE SGM 2-37 POWERED SAILPLANE(U) AIR FORCE ACADEMY CO K R CRENSHAW ET AL. JUN 83 USAFA-TN-83-9 2/2

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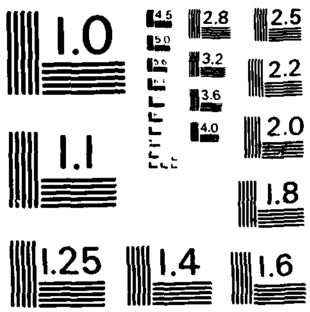

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

INITIAL FLIGHT TEST REPORT	1. AIRCRAFT TYPE SGM 2-37	2. SERIAL NUMBER N31AF

3. CONDITIONS RELATIVE TO TEST

a. DATE 3 May 1983	e. CONFIGURATION Cruise	i. FUEL LOAD 15.6 gallons
b. PILOT K. R. Crenshaw	f. INSTRUMENTATION Stopwatch	j. SURFACE WIND Calm
c. OBSERVER D. G. Picha	g. START UP GR WT 1779 lbs	k. WEATHER Clear
d. SORTIE TIME/TO TIME 2.4 / 0700 Local	h. START UP C G 24.5% MAC	l. GROUND BLOCK

4. TESTS PERFORMED

1. Pitot-static calibration runs at 60, 65, 70, 75, and 80 mph.
2. Climbs at 7,000 feet pressure altitude at 55, 60, 70, and 75 mph.
3. Climbs at 10,000 feet pressure altitude at 55, 64, 70, and 75 mph. Maximum level flight indicated airspeed at 10,000 feet pressure altitude was also determined.
4. Aircraft was weighed with full oil and fuel both with and without crew.

5. RESULTS OF TESTS *(Continue on reverse side if needed)*

1. Data reduction from Flight #1 pitot-static calibration runs indicated as much as 3 mph more position error than that determined by the manufacturer. With the light turbulence experienced on that intial flight, it was felt necessary to repeat runs in the cruise configuration only to check our earlier results. Position error found from the runs made on this flight was in line with the manufacturer's data.
2. Sawtooth climbs from 500 feet below to 500 feet above a pressure

6. REMARKS *(Continue on reverse side if needed)*

altitude of 7,000 feet were made with the mixture leaned and the throttle at full power. Absolutely no turbulence was experienced, and the aircraft climb rate appeared to be from 600 to nearly 800 feet per minute at the airspeeds indicated above. More conclusive results will be made when the data is standardized to the maximum aircraft gross weight of 1760 pounds and to standard atmospheric conditions. Engine RPM and MAP were 2400 and 22"Hg respectively.

3. Climbs through 10,000 feet pressure altitude were performed using the same procedure as at 7,000 feet. Again, no turbulence was experienced. Climb rates using the vertical velocity indicator were 500 to 650 feet per minute. Engine RPM and MAP were 2300 and 19"Hg respectively. The level flight indicated airspeed with full rated power was 103 mph. This was at 2550 rpm and 16.8 MAP. It was necessary to retard the throttle 2.2"Hg of manifold pressure in order not to exceed the maximum rated RPM of 2600.
4. The aircraft was leveled and weighed on this day using the procedures in the flight manual. With 6 quarts of oil and 15.6 gallons of fuel, the aircraft weighed 1415 pounds. With two crewmembers weighing a total of 364 pounds, the weight was 1779 pounds - 19 pounds over the certified gross weight of 1760 pounds. Additional or non-standard instrumentation consists of manifold pressure gage, "g"-meter, and outside air temperature gage, all estimated to weigh no more than 5 pounds total. Future data flights will be made with no more than 12 gallons of fuel in order to stay within the certified gross weight limit. See attachment 1 for details on aircraft weight and balance calculations.

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WEIGHT AND BALANCE

AIRCRAFT REG. NO. N31AF

DATE 3 May 1983

SCALE POSITION	SCALE READINGS (LBS)	(-)TARE	(=)WEIGHT (LBS)
LEFT WHEEL	732	3.0	729
RIGHT WHEEL	628	3.0	625
TOTAL MAIN	-	-	1354
TAIL WHEEL	61	0.0	61
TOTAL WEIGHT WITH FULL FLUIDS	-	-	1415

C.G. ARM (INCHES) $= \frac{61\ (232.0")}{1415} + (75.0") = 85.00"$

INITIAL FLIGHT TEST REPORT	1. AIRCRAFT TYPE	2. SERIAL NUMBER
	SGM 2-37	N31AF

3. CONDITIONS RELATIVE TO TEST		
a. DATE 5 May 1983	e. CONFIGURATION Cruise	i. FUEL LOAD 10.6 gallons
b. PILOT K. R. Crenshaw	f. INSTRUMENTATION Cassette Tape Recorder	j. SURFACE WIND Calm
c. OBSERVER D. G. Picha	g. START UP GR WT 1771 lbs	k. WEATHER Clear
d. SORTIE TIME/TO TIME 1.7 / 0715 Local	h. START UP C G 24.5% MAC	l. GROUND BLOCK

4. TESTS PERFORMED

1. Evaluation of spin susceptability was performed with idle power and pro-spin controls held for three seconds. Each of the entries below was started at 12,500 feet pressure altitude and 70 mph. A bleed rate of 2mph/sec was initiated from trim at 70 mph with pro-spin controls applied at the first indication of stall.
   a. Straight ahead entry, no airbrakes, stick full aft, left rudder.
   b. Straight ahead entry, no airbrakes, stick full aft, right rudder.
   c. Right 20 degree turning entry, no airbrakes, stick full aft, right rudder.
   d. Left 20 degree turning entry, no airbrakes, stick full aft, left rudder.
   e. Straight ahead entry, full airbrakes, stick full aft, left rudder.
   f. Straight ahead entry, full airbrakes, stick full aft, right rudder.
   g. Right 20 degree turning entry, full airbrakes, stick full aft, right rudder.
   h. Left 20 degree turning entry, full airbrakes, stick full aft, left rudder.
2. Evaluation of stalls was performed from an initial trim condition of 70 mph and between 9,500 and 10,500 feet pressure altitude. A bleed rate of 2mph/sec was used from the following entries.
   a. Power as required, no airbrakes, wings level.
   b. Power as required, with airbrakes, wings level.
   c. Idle power, no airbrakes, wings level.
   d. Idle power, with airbrakes, wings level.
   e. Power as required, no airbrakes, 20 degree right turn and left turn.
   f. Power as required, no airbrakes, 30 degree right and left turn.
   g. Power as required, no airbrakes, 45 degree right turn.
   h. Power as required, with airbrakes, 20 degree right and left turn.
   i. Power as required, with airbrakes, 30 degree right and left turn.
   j. Power as required, with airbrakes, 45 degree right and left turn.
   k. Idle power, with airbrakes, 20 degree left turn.
   l. Idle power, without airbrakes, 20 degree left turn.
   m. Idle power, without airbrakes, 20 degree right turn.
   n. Idle power, with airbrakes, 20 degree right turn.

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5. REMARKS

1. Spin Susceptability Evaluation:

ENTRY	NO. OF TURNS	ALTITUDE LOSS	RECOVERY V_i	STALL V_i
a.	2	700 feet	100mph	53mph

REMARKS - Stall was characterized by the left wing drop. As a warning, a pitch bobble at 54mph was noted. The post stall gyration was characterized by more roll than yaw and was very nose low. Full forward stick followed opposite rudder during the recovery. Full forward stick resulted in a steeper descent and rapid buildup of airspeed. Full airbrakes were extended followed by a 2.4 G pullup at 100mph. 2 turns for recovery.

ENTRY	NO. OF TURNS	ALTITUDE LOSS	RECOVERY V_i	STALL V_i
b.	1½	700 feet	90mph	53mph

REMARKS - Stall was characterized by right wing drop. Again, the post stall gyration consisted of more roll than yaw and very nose low pitch attitude. Less than forward stick was used to break the stall following opposite rudder. This resulted in a lower recovery airspeed, however, full airbrakes and a 2.4 G pullup were used. 3/4 turn required for recovery.

ENTRY	NO. OF TURNS	ALTITUDE LOSS	RECOVERY V_i	STALL V_i
c.	1	500 feet	95mph	53mph

REMARKS - Fell off on right wing at stall. After opposite rudder during the recovery, the stick was brought only about an inch off the back stop to break the stall and proved very effective. A 2.4 G pullup was used, however, airbrakes were not necessary. Pitch attitude did not appear as steep as in entry a. and b.

ENTRY	NO. OF TURNS	ALTITUDE LOSS	RECOVERY V_i	STALL V_i
d.	1	500 feet	98mph	53mph

REMARKS - Fell off on left wing at stall. Same recovery technique as in entry c. was used with a 2.4 G pullup. 2 turns required for recovery.

ENTRY	NO. OF TURNS	ALTITUDE LOSS	RECOVERY V_i	STALL V_i
e.	1¼	750 feet	94mph	54mph

REMARKS - Fell off on right wing at stall. Stick brought about an inch off the back stop during recovery. 2.4 G pullup used with airbrakes retracted as aircraft approached level flight. ¼ turn required for recovery.

ENTRY	NO. OF TURNS	ALTITUDE LOSS	RECOVERY V_i	STALL V_i
f.	1½	600 feet	97mph	54mph

REMARKS - Fell off on right wing at stall. Pitch attitude appeared to be approximately 80 degrees. ½ turn was required for recovery with a 2.2 G pullup.

ENTRY	NO. OF TURNS	ALTITUDE LOSS	RECOVERY V_i	STALL V_i
g.	1	1000 feet	95mph	57mph

REMARKS - Fell off to the right at stall. Pitch attitude appeared to be only 60 degrees. Again, the stick was brought only one inch off the back stop during recovery with approximately ¼ turn required for recovery.

5. REMARKS (cont'd)

1. Spin Susceptability Evaluation (cont'd):

ENTRY	NO. OF TURNS	ALTITUDE LOSS	RECOVERY V_i	STALL V_i
h.	1	750 feet	92mph	54mph

REMARKS - Fell off to the left at stall. Pitch attitude again appeared to be about 60 degrees. Same recovery technique as in entry g. was used with a 2.2 G pullup. ¼ turn required for recovery.

CONCLUSIONS - The SGM 2-37 exhibits high susceptability to spins. All stalls were characterized by an uncommanded angular motion, i.e., drop off on a wing. Generally, the aircraft tended to drop off on the right wing during straight ahead entries and in the direction of the turn during turning entries. Once into the post stall gyration, the motion is characterized by more roll than yaw in a very steep pitch attitude. Airbrakes may be required to avoid excessive airspeed buildup and altitude loss. Since all recovery airspeeds exceed the aircraft's maneuvering speed, care should be taken during the pullout so as not to exceed G limits. Recommended recovery from all entries is opposite rudder followed by bringing the stick only one inch off the back stop. Generally, the aircraft will recover within ¼ to ½ turn. Post stall gyrations with airbrakes extended result in shallower pitch attitudes than with airbrakes retracted. Altitude loss was between 500 to 1000 feet with recovery airspeeds between 90 and 100mph.

2. Stall Evaluation:

ENTRY	START ALT.	STALL V_i	RECOVERY ALT.	RECOVERY V_i
a.	10380ft	48mph	10400ft	80mph

REMARKS - Fell off on right wing. 1.8 G pullup.

ENTRY	START ALT.	STALL V_i	RECOVERY ALT.	RECOVERY V_i
b.	10450ft	52mph	10050ft	90mph

REMARKS - Fell off on right wing. ½ turn nose low.

ENTRY	START ALT.	STALL V_i	RECOVERY ALT.	RECOVERY V_i
c.	9800ft	52mph	9659ft	80mph

REMARKS - Fell off on right wing. 1.8 G pullup.

ENTRY	START ALT.	STALL V_i	RECOVERY ALT.	RECOVERY V_i
d.	10500ft	53mph	10000ft	87mph

REMARKS - Fell off on left wing to nearly 60 degrees of bank. Used 1.4 G recovery.

CONCLUSIONS - Stall entries a. through d. were wings level and were generally characterized by falling off on the right wing. No buffet or G-break was experienced as a warning prior to stall. The aircraft stall is defined by an uncommanded angular motion. Power was not adjusted during any of the recoveries. The lowest stall speed with the smallest

5. REMARKS (cont'd)

2. Stall Evaluation (cont'd)

altitude loss was with power on and no airbrakes. The highest stall speed with the greatest altitude loss was with idle power and full airbrakes.

Stall entries e. through n. were performed from turns. The following summarizes the observations from turning stall entries.

POWER SETTING	CONFIGURATION	BANK ANGLE	STALL V_1	REMARKS
as required	no airbrakes	20 deg's	55mph	Aircraft rolled opposite turn at stall. Recovered with less than 100ft altitude loss at 80mph with 1.5 G pullup.
as required	no airbrakes	30 deg's	60mph	Aircraft rolled left at stall with right turn and rolled left with left turn. Recovery at 80mph with 2.0 G pullup.
as required	no airbrakes	45 deg's	52mph	Done from right turn only. Nose sliced to the right at 52mph resulting in steep nose low attitude. 2.3 G pullup at 100mph with 400ft altitude loss.
as required	with airbrakes	20 deg's	53mph	Stall warning consisted of mild bucking and then rolling motion opposite turn direction. Altitude loss was 200 ft with 74mph pullup.
as required	with airbrakes	30 deg's	57mph	Left wing dropped off at stall with turns in both directions.

[illegible]. REMARKS (cont'd)

2. Stall Evaluation (cont'd)

POWER SETTING	CONFIGURATION	BANK ANGLE	STALL V_i	REMARKS
				Only 200 ft was lost during recovery with 70mph pullup.
as required	with airbrakes	45 deg's	58mph	Aircraft rolled opposite turn direction. 100ft altitude loss during recovery with pullup at 70 mph.
idle	with airbrakes	20 deg's	58mph	Aircraft rolled left during both turn directions. Aircraft rolled to 80 degrees of bank nose low and lost 300 ft with 90mph pullup.
idle	no airbrakes	20 deg's	50mph	Aircraft rolled same as turn direction at stall. Altitude loss during recovery was 200ft.

CONCLUSIONS - Stall speeds are again higher with airbrakes than without for most cases using the same power setting for comparison. Uncommanded angular motion defines the stall. The aircraft did not exhibit a consistent tendency to roll off on one particular wing during approaches to stall. All recoveries were accomplished by releasing back pressure and using aileron and rudder to roll wings level during the pullup to level flight. No power adjustments were necessary.

INITIAL FLIGHT TEST REPORT	AIRCRAFT TYPE: SGM 2-37	SERIAL NUMBER: N31AF

CONDITIONS RELATIVE TO TEST

a. DATE: 9 May 1983	e. CONFIGURATION: Power Cruise and Approach	i. FUEL LOAD: 12 gallons
b. PILOT: K. R. Crenshaw	f. INSTRUMENTATION: Stopwatch and Recorder	j. SURFACE WIND: Calm at Takeoff
c. OBSERVER: D. G. Picha	g. START UP GR WT: 1757 lbs	k. WEATHER: Clear
d. SORTIE TIME/TO TIME: 1.7 / 0655 Local	h. START UP C G: 24.5% MAC	l. GROUND BLOCK:

4. TESTS PERFORMED

1. Pitot-static calibration runs at indicated airspeeds of 55, 80, 90, and 100 mph flown at 7500 feet pressure altitude over 1.7 statute mile ground course. All runs performed with airbrakes retracted.
2. Climbs and descents performed at 9000 feet pressure altitude at indicated airspeeds of 55, 60, and 65 mph.

5. RESULTS OF TESTS *(Continue on reverse side if needed)*

1. These runs completed the pitot-static calibration of the aircraft. The position error given by the manufacturer in the flight manual appears to be accurate. Our results conform very closely. Both flight manual airspeed calibration and our validation calibration assume no instrument error. Also, no additional position error is introduced by flying with airbrakes extended.
2. Climbs and descents at 9000 feet were cut short due to low fuel. Data will be reduced to standard atmospheric conditions and 1760 pounds gross weight during final report preparation. More data will be required on subsequent flights. Primary objective is to obtain a throttle idle performance polar from the descent data.

6. REMARKS

Cockpit -

1. Pilot's microphone was relocated to a position on the instrument panel and was much easier to pick up and stow. Recommend this modification on other aircraft.
2. Fuel quantity gage is erratic during flight and does not give a sufficiently accurate indication of fuel remaining. On the ground with the tank visually filled to capacity, the fuel quantity on the gage only indicates 3/4 full. After draining nearly all fuel from the aircraft, the gage was calibrated to 10 gallons with the indicator showing about ½ full. Maximum capacity is published as 15.6 gallons.
3. It was found that with proper technique that the airbrake handle on the left side can be locked.

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INITIAL FLIGHT TEST REPORT

1. AIRCRAFT TYPE SGM 2-37	**2. SERIAL NUMBER** N31AF	

3. CONDITIONS RELATIVE TO TEST

a. DATE 9 May 1983	**e. CONFIGURATION** Cruise and Power Approach	**i. FUEL LOAD** 12 gallons
b. PILOT K. R. Crenshaw	**f. INSTRUMENTATION** Cassette Tape Recorder	**j. SURFACE WIND** 140/10 knots at takeoff
c. OBSERVER D. C. Picha	**g. START UP GR WT** 1757 lbs	**k. WEATHER** Clear
d. SORTIE TIME/TO TIME 1.3 / 0900 Local	**h. START UP C G** 24.5% MAC	**l. GROUND BLOCK**

4. TESTS PERFORMED

1. Takeoff ground roll performance at liftoff speeds of 52, 55, 60, and 65 mph indicated. All takeoffs started with throttle at idle 800 rpm, brakes released, followed by approximately four seconds to full power application.
2. Landing techniques were qualitatively evaluated using approach speeds of 65 and 70 mph indicated. Approaches were made with the following configurations at both airspeeds:
   a. full airbrakes, throttle idle

[redacted]

   b. partial airbrakes, throttle idle
   c. without airbrakes, throttle idle
   d. full airbrakes, power as required to maintain glide path and airspeed
3. Crosswind landing evaluation with 15 knot crosswind.

5. RESULTS

1. Gusty wind conditions and strong crosswinds precluded obtaining accurate takeoff data. This evaluation will be repeated on later flights.

[redacted]

2. Of all the approach techniques evaluated, an approach at 70 mph, throttle idle, and partial airbrakes or airbrakes as required provided the most glide path and airspeed control. Full airbrakes were extended on touchdown. This technique is similar to what the cadets will see when transitioning to the SGS 2-33 sailplane. Approaches at 70 mph, throttle idle, and full airbrakes are satisfactory but result in steeper approaches. In this configuration, rounding out high without the benefit of ground effect can result in hard landings. With full airbrakes, the aircraft exhibits little tendency to float in ground effect. Flying approaches without airbrakes, the aircraft will float in ground effect down to the stall speed. Landing distance without airbrakes is excessive. Approaches with full airbrakes and power as required were shallower on glide path and entirely normal as in a conventional powered aircraft. Throttle was retarded approaching the landing threshold followed by a normal transition to flare and landing. All approach techniques were repeated for an approach airspeed of 65 mph. Controls felt more sluggish at 65 mph and less margin for recovery from a high roundout was provided. This airspeed was determined to be too slow for all the approach techniques evaluated.
3. The aircraft was flown in crosswinds up to 15 knots at both 65 and 70 mph. All the techniques for approach indicated above were performed. In all cases, the normal wing low, opposite rudder procedure was used. Approaches at 70 mph were far more controllable. In strong crosswinds and gusty conditions, the power on, with full airbrakes technique afforded slightly more directional control and easier transition to a flare attitude than a throttle idle approach with airbrakes as required. The tailwheel should be lowered to the runway as soon as possible to avoid loss of directional control as the aircraft slows after touchdown. For takeoff into strong crosswinds, crosswind controls need to be applied prior to beginning the takeoff roll. The tailwheel should be kept on the runway longer in order for the rudder to become more effective prior to takeoff airspeed. Recommend 45 to 50 mph.

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INITIAL FLIGHT TEST REPORT

1. AIRCRAFT TYPE	2. SERIAL NUMBER
SGM 2-37	N31AF

3. CONDITIONS RELATIVE TO TEST

a. DATE 11 May 1983	e. CONFIGURATION Cruise	i. FUEL LOAD 14 gallons
b. PILOT K. K. Crenshaw	f. INSTRUMENTATION Stopwatch and Recorder	j. SURFACE WIND Calm
c. OBSERVER D. G. Richa	g. START UP GR WT 1769 lbs	k. WEATHER Partly Cloudy
d. SORTIE TIME/TO TIME 2.3 / 0615 Local	h. START UP C G 24.5% MAC	l. GROUND BLOCK

4. TESTS PERFORMED

1. Climbs at 55, 60, 70, 75, and 80 mph.
2. Descents at 60, 70, 75, and 80 mph with airbrakes retracted.

5. RESULTS OF TESTS *(Continue on reverse side if needed)*

1. All climbs were evaluated at a test altitude of 9000 feet pressure altitude. Best rate of climb appears to be between 60 and 70 mph. More conclusive results will be obtained when data reduction is complete. Climbs at 60 and 70 mph were only made in one direction and will have to be repeated on later flights in order to eliminate wind gradient effects. The maximum airspeed at 9000 feet with full power (2600 rpm) is 104 mph. This represents the zero rate of climb airspeed.

~~6. REMARKS (Continue on reverse side if needed)~~

2. All descents were evaluated at a test altitude of 9000 feet pressure altitude. The aircraft bucked and wing rocked at 55 mph and for this reason descents were not performed at that airspeed. Descents at 60 and 70 mph were only done in one direction and for the same reason as mentioned above will be repeated on later flights.

6. REMARKS
   1. The mission was terminated before all data points were obtained due to weather conditions deteriorating at the Academy Airfield.
   2. Attempts were made to coordinate airspace requirements with T-41 Eagle Control, however, we were only allowed in their areas for about 5 to 10 minutes. This was insufficient time to gather the data we needed. We were given as many as three area assignments during the course of this flight. Most of the mission was flown south toward Pueblo and to the west of the T-41 north-south corridor. Some mutual cooperation here would have allowed more efficient use of flying time and perhaps completion of all data requirements.
   3. Of the 2.3 hrs flying time indicated above, .3 hours were flown from Peterson to the Academy after we were diverted due to weather.

AFFTC FORM APR 74 365 REPLACES AFFTC FORM 365 ONETIME, MAR 74, WHICH IS OBSOLETE

INITIAL FLIGHT TEST REPORT

1. AIRCRAFT TYPE	2. SERIAL NUMBER
SGM 2-37	N31AF

3. CONDITIONS RELATIVE TO TEST

a. DATE 12 May 1983	e. CONFIGURATION Cruise and Power Approach	i. FUEL LOAD 12 gallons
b. PILOT T. Taylor	f. INSTRUMENTATION Cassette Tape Recorder	j. SURFACE WIND Calm
c. OBSERVER E. P. Crenshaw	g. START UP GR WT 1750 lbs	k. WEATHER Clear
d. SORTIE TIME/TO TIME .8 / 1347 Local	h. START UP C G 24.5% MAC	l. GROUND BLOCK 6580 ft PA and 62 degrees F.

4. TESTS PERFORMED

Flew normal mission profile. Normal takeoff and climb to 12,000 ft MSL. Discussed and demonstrated attitude flying, glides, airspeed control with pitch, and control effectiveness. Made two low approaches to the auxillary field using a normal sailplane traffic pattern. Airspeed flown in the traffic pattern was 70 mph. Following the low approaches, a climb back to 12,000 ft was performed where the throttle idle, wings level and turning stalls were demonstrated. A glide back to a full stop landing terminated the mission after 45 minutes of flying time.

5. RESULTS OF TESTS *(Continue on reverse side if needed)*

The aircraft demonstrated an excellent capability in performing all the mission essential maneuvers required during a typical cadet sortie. Based on this mission it will not be necessary to fly another sortie to confirm the operational capability of the aircraft. Flight time from takeoff to 12,000 ft is 9 minutes flying at 64 mph.

6. REMARKS *(Continue on reverse side if needed)*

1. Confirmed the problem with the left seat airbrake handle. Discussed and evaluated the possibility of perhaps shortening the handle to alleviate the problem of it contacting the left seat crewmember's leg. Shortening the handle approximately four inches does not significantly increase the force required to extend or retract the airbrakes.

2. Throttle idle operation for extended periods of time may require clearing the engine periodically to prevent spark plug fouling. This is currently being done in 30 second intervals. The engine manufacturer needs to be contacted in order to find out the exact requirements for engine clearing during throttle idle operation.

AFFTC FORM APR 74 365 — REPLACES AFFTC FORM 365 ONETIME, MAR 74, WHICH IS OBSOLETE

INITIAL FLIGHT TEST REPORT	1. AIRCRAFT TYPE SGM 2-37	2. SERIAL NUMBER N31AF

3. CONDITIONS RELATIVE TO TEST

a. DATE [illegible] May [illegible]	e. CONFIGURATION Power Cruise and Approach	i. FUEL LOAD 15.0 gallons
b. PILOT R. [illegible]. Crenshaw	f. INSTRUMENTATION Tape Stopwatch and Recorder	j. SURFACE WIND 330/10 knots
c. OBSERVER [illegible] Lehn	g. START UP GR WT 1775	k. WEATHER Clear
d. SORTIE TIME/TO TIME 2.8/0604 Local	h. START UP C G 24.5% MAC	l. GROUND BLOCK 6500 ft PA and 32°F

4. TESTS PERFORMED

1. Determined maximum airspeed at 7000 feet pressure altitude.
2. Descents with throttle idle, airbrakes extended and at a test altitude of 9000 feet pressure altitude were performed at indicated airspeeds of 60, 65, 70, 75, and 80 mph. Descents were made at each airspeed by flying East and West. This was done in order to eliminate wind gradient effects.
3. Longitudinal static stability was evaluated from a 70 mph, 9000 feet trim condition with airbrakes retracted. This was done for two power conditions - throttle idle and throttle as required for level flight. The slow speed upset was 55 mph and the high speed upset 90 mph. These speeds were approached in 5 mph increments from the trim airspeed of 70 mph indicated.
4. Maneuvering flight characteristics were evaluated from a 1 "G" trim condition of 70 mph and between 8500 and 9500 feet with airbrakes retracted and throttle idle. The aircraft was maneuvered to the left from 1.2 to 1.6 "G's" and to the right from 1.2 to 1.8 "G's".
5. A controllability evaluation in approaches to 1 "G" stalls was performed between 8500 and 9500 feet pressure altitude with the throttle at idle. This was accomplished with the airbrakes retracted and with the airbrakes extended.
6. Aileron rolls from 45 to 45 degrees of bank were performed to investigate roll response with ½ and full aileron deflection. This was done both left and right and with rudder free and coordinated. Airbrakes were retracted for all rolls.
7. Aircraft dynamic characteristics were investigated with the aircraft trimmed for level flight at 70 mph and 9000 feet pressure altitude. The phugoid and Dutch roll dynamic modes were analyzed.
8. Takeoff performance was evaluated at Colorado Springs Municipal Airport. Takeoff ground run was measured using takeoff speeds of 52, 55, and 60 mph. Two full aft stick takeoffs were performed.

5. RESULTS OF TESTS:

1. Maximum airspeed was determined to be 107 mph and will serve to complete the 7000 feet pressure altitude climb data obtained on 3 May.
2. Descents were performed with airbrakes extended in order to derive a performance polar and to validate the approach configuration glide ratio of at least 7 to 1.
3. Longitudinal static stability data will be used to qualitatively compare stick forces and stick displacement of the SGM 2-37 with the SGS 2-33.
4. Maneuvering flight data will be used to qualitatively compare stick forces and displacement of the SGM 2-37 with the SGS 2-33 in other than 1 "G" flight.
5. Controllability in approach to 1 "G" stalls was investigated and the aircraft exhibited satisfactory three axis control down to within 5 mph of the stall speed for both airbrake and no airbrake approaches

. RESULTS OF TESTS: (cont'd)
to stalls.

6. As expected, the aircraft has its highest roll rate with full aileron deflection and coordinated rudder. Adverse yaw was more noticeable with full aileron deflection and rudder free rolls.

7. The phugoid dynamic mode was stable with the aircraft returning to trim in approximately three minutes. The Dutch roll exhibited three to five overshoots before damping out. The Dutch roll dynamic mode was excited by using a ½ rudder deflection doublet and by using a release from a full rudder steady straight sideslip.

8. Takeoff performance was repeated in order to verify the ground run performance found on earlier flights. Wind conditions were calm with runway gradient and pilot technique being the only significant factors. Takeoff at 52 mph was performed using the normal takeoff technique. Takeoffs at 55 and 60 mph were made by applying forward stick force to keep the aircraft on the runway. In all cases the tail began flying at 40 to 42 mph. The two full aft stick takeoffs were made with takeoff trim set and resulted in close to 50 pounds of stick force in order to keep the tail on the ground. The aircraft lifted off in a three point attitude at 52 mph in each case and resulted in a shorter ground run than that determined from the other takeoff techniques. Aircraft pitch attitude is higher and acceleration after liftoff is slower with full aft stick takeoffs. This puts the aircraft closer to its stall speed for a longer period of time after liftoff and would not be a good technique in gusty wind conditions. Releasing back pressure right after liftoff may result in contacting the runway again if done too abruptly.

INITIAL FLIGHT TEST REPORT	1. AIRCRAFT TYPE	2. SERIAL NUMBER
	SGM 2-37	N31AF

3. CONDITIONS RELATIVE TO TEST

a. DATE: 2[illegible] May 19[illegible]	e. CONFIGURATION: Cruise	i. FUEL LOAD: 15.6 gallons
b. PILOT: R. [illegible] Crenshaw	f. INSTRUMENTATION: Tape Stopwatch and Recorder	j. SURFACE WIND: Calm
c. OBSERVER:	g. START UP GR WT: 1648.0 lbs	k. WEATHER: Scattered Clouds
d. SORTIE TIME/TO TIME: 1.2/0802 Local	h. START UP C G: 26.6% MAC	l. GROUND BLOCK:

4. TESTS PERFORMED

1. High altitude powered operation to 18,000 feet pressure altitude.
2. Power off glides from 17,500 to 10,500 feet pressure altitude at 60, 65, 70, 75, and 80 mph.
3. Prop windmilling engine start from 10,500 to 10,000 feet pressure altitude.
4. Spiral stability investigation at 9,000 feet MSL and 70 mph with airbrakes retracted.
5. Engine shutdown at 10,000 feet MSL and prop windmilling engine start from 9500 to 9000 feet MSL.
6. Solo control force evaluation.

5. RESULTS OF TESTS:

1. Time from takeoff to 18,000 feet pressure altitude was 26 minutes. The climb was accomplished with airbrakes fully retracted and at 64 mph indicated airspeed. Engine rpm was 2350 throughout the climb. Other engine indications also remained the same. Oil pressure was 60psi, fuel pressure 40psi, and oil temperature 100 degrees F. The following table shows other parameters at 2000 feet increments:

Altitude (ft PA)	Manifold Pressure (" Hg)	VVI (fpm)	Time (local)
10,000	19.5	600	0808
12,000	18.0	500	0812
14,000	16.5	350	0817
16,000	15.0	450	0823
18,000	13.5	350	0828

After level off at 18,000, the maximum level flight airspeed was determined to be 90 mph indicated. The engine exhibited a tendency to exceed 2600 rpm and the throttle was retarded slightly at 90 mph. Stabilized at 90 mph, the engine rpm was 2600, manifold pressure 13.5, and outside air temperature was observed to be +10 degrees F. Some turbulence was experienced while passing 16,000 feet which may account for the apparently higher climb rate at that altitude.

2. Engine shutdown checklist was performed at 18,000 feet. The aircraft was slowed to 55 mph in order to decrease the time required for the prop to come to a complete stop. Winds did not appear to be a factor during the glides from 17,500 to 10,500 feet. However, some turbulence was experienced while flying the 75 mph point from 13,000 to 12,000 feet. A cloud deck at 14,000 feet necessitated performing the glides in different directions and over different areas which may cause some inconsistencies during data reduction. The aircraft flew and handled like a glider with less of a glide ratio than with the engine at idle. Data analysis should substantiate this.

5. RESULTS OF TESTS: (cont'd)

3. During the prop windmilling engine start, the prop began to move at 100 mph and at 117 mph windmilled to a start. This required approximately 500 feet of altitude.

4. From a trimmed condition at 9000 feet MSL, 70 mph (13" MAP and 1400 rpm), the spiral stability of the aircraft was investigated from both left and right 20 degree bank turns. With a 20 degree bank turn to the left, controls released, the aircraft rolled to approximately 45 degrees of bank in 20 seconds, gaining 10 mph of airspeed and losing 150 feet of altitude. From a right 20 degree bank turn, controls released, the aircraft rolled back to wings level losing only 100 feet of altitude. Sprial instability to the left does not appear to be a problem. This may be a function of engine torque and lateral center of gravity location.

5. A second engine shutdown was performed at 10,000 feet MSL. A prop windmilling engine start was commenced at 9500 feet and complete by 9000 feet with the engine windmilling to a start at 110 mph. This method of engine start is effective and avoids more frequent use of the electric starter, however, at least 500 feet of altitude may be required for a successful start.

6. Control forces are not noticeably different for solo flight as compared to dual.

6. REMARKS

1. This flight was flown solo to accomodate an oxygen system secured in the left seat. The oxygen system worked well and a standard Air Force issue helmet and mask were used. A wiring package was improvised by Mr. Scott Christenson with a microphone switch secured to the control stick by velcro tape. This setup was interfaced with a cassette tape player for recording in-flight data. The only noticeable problem was with helmet and canopy clearance. To alleviate this problem, seat height was lower and visibility somewhat less. A parachute was also worn. Combined weight of helmet, oxygen system and parachute was 51 pounds.

2. With engine shutdown, the altimeter appears to be extremely susceptible to lag and hangup error. This problem even exists with the engine operating in idle, however, to a lesser degree.

INITIAL FLIGHT TEST REPORT	1. AIRCRAFT TYPE SGM 2-37	2. SERIAL NUMBER N32AF

3. CONDITIONS RELATIVE TO TEST

a. DATE 27 May 1983	e. CONFIGURATION Cruise and Power Approach	i. FUEL LOAD 8.0 gallons
b. PILOT K. R. Crenshaw	f. INSTRUMENTATION Stopwatch & Tape Recorder	j. SURFACE WIND 340/5 knots
c. OBSERVER D. G. Picha	g. START UP GR WT 1684.25 lbs	k. WEATHER Clear
d. SORTIE TIME/TO TIME 1.5/0642 hrs Local	h. START UP C G 22.7% MAC	l. GROUND BLOCK 6325 ft PA and 46°F

4. TESTS PERFORMED

1. Engine off glide at 60 mph from 11,500 to 10,500 feet pressure altitude to the East.
2. Engine off glide at 65 mph from 10,000 to 9,000 feet pressure altitude to the West.
3. Engine start from 9,000 to 8,500 feet pressure altitude using electric starter.
4. Engine off glide at 70 mph from 11,500 to 10,500 feet pressure altitude to the East.

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5. Engine off glide at 75 mph from 10,000 to 9,000 feet pressure altitude to the West.
6. Engine start from 9,000 to 8,500 feet pressure altitude using electric starter.
7. Engine off glide at 80 mph from 11,500 to 10,500 feet pressure altitude to the East.
8. 1 "G" stall investigation with airbrakes retracted from 10,500 to 10,000 feet pressure altitude.
9. 1 "G" stall investigation with airbrakes extended from 10,000 to 9,500 feet

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

pressure altitude.

10. Engine out pattern and landing, engine idle pattern and landing, and engine out pattern and landing to a full stop.

5. RESULTS OF TESTS:

1. Engine off glides were repeated at 60, 65, 70, 75, and 80 mph in order to substantiate the lower glide ratio derived from the engine out data obtained on mission flown on 23 May 1983. It was also felt that a comparison between N31AF and N32AF was important in regard to engine out performance. Data was successfully obtained at all five airspeeds in N32AF and data reduction will again yield a power off performance polar. All glides were performed with airbrakes retracted.

2. During all engine starts, the electric starter was used. The engine turned over two to three times before starting. No priming was required and the mixture was set at full rich until start then leaned to the stop. Engine oil temperature stayed at the low end of the normal operating range throughout all engine out maneuvers. Starting from minimum sink airspeed of 59 mph, only 300 feet of altitude was lost from the time the engine start checklist was initiated to completion of the engine start. For engine out pattern work, recommend that the mixture be left in full rich, fuel pump on, throttle above idle position, magneto switch in both, and electric fuel pump on.

3. Engine out pattern characteristics are very similar to flying with the throttle at idle. All patterns were flown at 70 mph with sink rates nearly the same for both throttle idle and engine off approaches. The same airbrake technique was used in both cases - full airbrakes on base, partial airbrakes turning base to final, partial airbrakes on final to touchdown and full airbrakes at touchdown. Patterns were flown from the normal sailplane entry point at 7500 feet MSL. Rates of sink appear to be twice what they are in the SGS 2-33. Winds in all cases were right down the runway at 3 to 5 knots. Touchdowns were all within the first 1000 feet of runway.

4. Engine out stall characteristics for both airbrake positions revealed a mild

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5. RESULTS OF TESTS: (cont'd)

buffet from 2 to 5 knots above the stall speed. All stall investigations were initiated from a 70 mph glide using a 2 mph per second bleed rate. The following table summarizes our results:

Airbrake Position	Buffet V_i (mph)	Stall V_i (mph)	Remarks
Retracted	53	52	Fell off on left wing at stall. Lost 200 feet from stall to recovery.
Extended	58	53	Fell off on left wing at stall. Lost 250 feet from stall to recovery.
Retracted	55	53	Fell off on left wing at stall. Lost 100 feet from stall to recovery.
Extended	58	53	Fell off on left wing at stall. Lost 150 feet from stall to recovery.

All stall speeds were again defined by an uncommanded roll. Differences between stall speeds for airbrakes retracted and extended are not significant. All recoveries were made by simultaneously releasing back pressure, rolling wings level, and pulling the nose to the horizon at between 60 and 65 mph.

6. REMARKS:

1. Leaning the mixture lever to the stop appears to increase the rate of climb by 100 fpm as opposed to operating at full rich.

2. Radio in N32AF had poor reception in both manual and automatic squelch settings.

3. Fuel gage only indicates 3/4's full when tank is filled visually to capacity. This observation was the same as that made for N31AF.

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